POWER

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Rights and Service

YOU ALL know him, the scrappy individual who is so jealous of his rights and so assertive in his insistence upon them.

He is continually croaking about the impositions of which he is the subject—impositions by the government, by the public-service corporations, by his employer, by big business, by the local tradesmen, by the driver who hogs the road.

But he does not think of the duties and responsibilities that go with his rights and upon which those rights are founded.

No government can persist without the tolerance of the governed, but if the governed do not take an intelligent interest in affairs, in the shaping of policies and the selection of the men who are to carry them out, of what avail are their sovereign rights as citizens?

We hear much of the sacred rights of property and of labor, but are property and labor always considerate of the rights of others?

The world owes every man not a living, but a chance to make a living. Somebody has truly said that service is the rent that one pays for the place that one occupies in the social order.

The service is not always commensurate with the emoluments that go with the position, but it ought to be.

There is a growing appreciation on the part of business, big business and big business men especially, and of the big thinkers among the workers, that they are parts of a great interdependent social-economical system; that a blind struggle for individual advantage can result in nothing but continued confusion, with affluence for some, disaster for the less able and fortunate and a greater cost to everybody.

Out of it all must come eventually an orderly organization of our industrial and commercial facilities and man-power with a chance for everybody to render the service of which he is best capable, be it manual or executive, toward the best utilization of our resources and their adaptation to the uses of the race and the distribution of the products of the impressment of labor upon them in substantial proportion to the service rendered by their recipients.

Fig. 1—Coal distributed on the pile by a tractor-drawn scraper

The Why, When and How of Storing Bituminous Coal

BY W. T. CONLON
Mechanical Engineer, Utica Gas & Electric Company, Utica, N. Y.

BY PLACING coal so as to prevent air circulation through it, a pile twenty feet high showed no indications of fires after twenty-six months' storage.

COAL handling, particularly its storage, is a problem that is receiving more consideration daily. Books have been written and hours could be spent discussing why, when and how we should handle and store coal. Opinions on this subject vary widely. The storage of soft coal is one of the salient factors for consideration in the industrial world. In general, the question "why we should" store coal, can be answered by stating that production can be made continuous rather than seasonal and prices will be stabilized. "When we should" can be answered in about the same way, but "how we should" store coal is the question that must be decided for each plant and organization, and a few observations will be given on the subject.

Large Volumes in Storage

It has been stated by many who have studied and written extensively on the subject, that the storage of coal by consumers is the all important balance wheel between fluctuation and production. It is the consumer's insurance against temporary transportation failures, and it is the only protection yet devised for the consumer against protracted general stoppage of coal mining or railroad difficulties. In a sense this statement can be considered as emphasizing why more careful thought should be given to the handling and storage of coal.

Bituminous, or soft coal is the fuel about which industry practically revolves and the one that presents the greatest difficulties in storage. For general information as to the storage and use of this coal, it can be stated that at one time within the last five years 60,000,000 tons of bituminous coal were in storage in various industries of the United States; the railroads had 28 per cent, public utilities including byproduct gas 22 per cent, steel works 4 per cent, coal dealers 14 per cent, and the remaining 32 per cent was distributed among the rest of the industries.

Heat and Other Losses

The loss in heat value from bituminous coal in storage may be considered negligible. This loss seldom exceeds one per cent of the total heat contained per pound. The financial loss from disintegration in lumps may at times be considerable, due to the loss of the "fines." There are exceptions, however, and actual tests show that the heat loss of some coals in storage is quite considerable, but as a rule it is difficult to determine in laboratory analysis. There is at times, a change of steaming qualities in the coal due to weathering. This does not materially change the heat value of the coal, but it does affect the steaming qualities or the ease with which the heat is liberated when used under boilers. The general result that may be looked

for, is that certain coals that have been put in storage for any length of time do not burn as readily as before storage, especially where high rates of combustion are required. The common expression used by old-time firemen, that a coal has "lost its heat" will generally be found to apply to coals that are taken from storage. In reality the coal has absorbed a quantity of oxygen which has changed its structure, therefore changed the method that must be used in firing.

Losses Due to Spontaneous Combustion

The greatest loss due to storage is that caused by spontaneous combustion. This condition is most common in soft-coal piles. The monetary value of these losses every year amounts to many thousands of dollars. Spontaneous combustion is due to a balanced condition being reached in the pile between excess and insufficient air. This condition arises in some one spot in the pile, which is indicated by a rise in temperature at that location, and if removed immediately, there will be no loss. If the coal is allowed to remain and the heat to continue above a temperature of about 150 deg. F., fire is likely to result, and losses up to 15 per cent of the total coal pile in one year are not uncommon. This dangerous temperature, approximately 150 deg. F., usually occurs at from ten to fifteen feet from the the surface of the average coal pile.

The temperature of a coal pile can without particular danger rise to 125 deg., but when the indicator shows the danger point of 150 to 180 deg. is being reached, there is but one thing to do to avoid fire, and that is to dig out the heated section. Water will not put out a fire in the pile, but will conduct it to another part of the pile by raising the temperature. The coal can be dug out and placed in loose layers and sprinkled with water, after which it is allowed to cool down in the air, and then it can be replaced in the pile without any particular danger of igniting again.

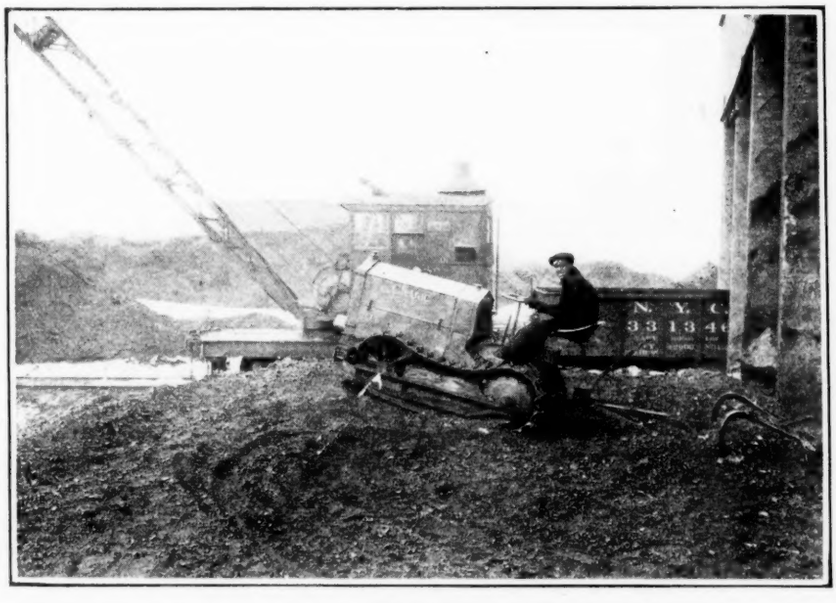


Fig. 2—Tractor packs down the coal as well as distributes it on the pile

By way of explanation, for combustion to exist oxygen must be present. Spontaneous combustion is caused by the combustible material absorbing oxygen. This absorption is accompanied by the development of heat. The increase in temperature of the material causes it to absorb additional oxygen. In a coal pile where there are many voids, as the oxygen is absorbed it is automatically replaced, therefore, there is air circulation in the pile.

Experiments have proved that air in certain coal piles will change once in about nine and a half hours. If this circulation is reduced, then the quantities of oxygen available to be absorbed by the coal will be decreased. The main cause for the absorption of oxygen is the voids between lumps. Filling these voids with coal will cut down the air circulation and reduce the absorption of oxygen, which will reduce the possibility of spontaneous combustion.

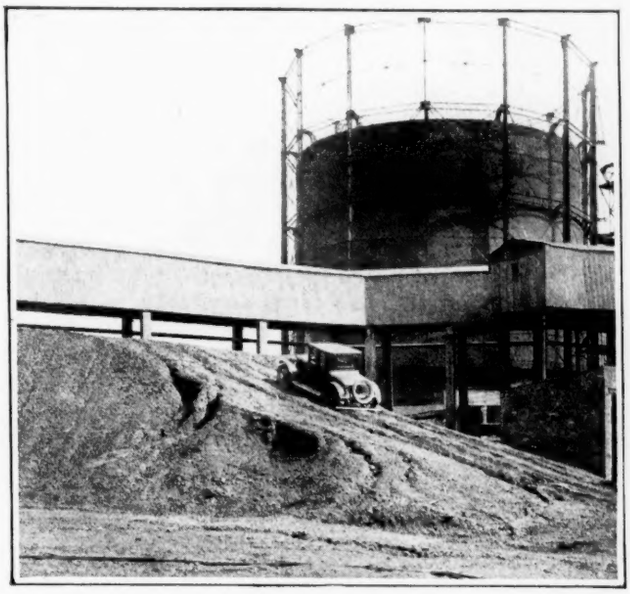


Fig. 3—Coal packed so hard that an automobile can run up onto the pile

Other experiments have been run by putting coal in a wooden container equipped with doors with thermometers inserted in the coal. When the doors were allowed to remain open, the temperature in the pile would gradually rise, but on closing the doors the temperature decreased, which indicates that cutting down the air circulation eliminates, to a large degree, the possibility of fire in a coal pile.

Coal containing sulphur in the form of iron pyrites or any other substance having affinity for oxygen is always more likely to burn when stored, than other types of coal. One substance that is common in coal is mineral charcoal. This has a great tendency to absorb oxygen and is found in layers in the coal seams. It is commonly called "mother of coal" by miners and those familiar with the mining industry. It is quite similar to charcoal as made from wood, and its presence in coal piles increases the danger from fire.

At one time statements were made that the only way that bituminous coal should be stored without danger

from fire was to submerge it under water. This has been proved incorrect by common practice, and one, organization which invested considerable money in 8,000 tons of submerged storage ten years ago, at present has over 25,000 tons in open-air storage without fire in the pile. There are numerous under-water storages, but only a few of the storage piles can be submerged completely should a fire start. The use of abandoned canals has afforded the opportunity for under-water storage to several organizations. The main disadvantage of under-water storage is its high first cost for relatively small storage.

Method of Storing in Layers

A suggested method of storing is that the coal be placed in layers approximately three feet or less in depth, by the use of drag scrapers or any other method, keeping in mind that the voids should be filled with "fines" and a more or less uniform structure maintained through the pile. The danger of loss by fire in several utility organizations has led to considerable study concerning the storage of soft coal, and it has been generally conceded that if in addition to layer storage the coal is rolled or packed, further assurance is given that the fire hazard will not be so great. This method also increases the capacity of storage for a given area in that the coal is compressed from 55 lb. per cu.ft. to as high as 69 lb. per cu.ft., depending on the kind and grade of coal.

In the storage of coal by methods other than rolling or packing and the drag scraper, great care must be taken. When gantry or locomotive cranes are used for piling, unless particular care is given to the way the coal is placed, uniformity of lumps and fines throughout the pile cannot be obtained. If the lumps are allowed to go to the outside of the piles and the fines to the center, and if the piles are run parallel, this forms an excellent ventilating condition between the piles to cause spontaneous combustions. If, however, the lumps and fines are intimately mixed and preferably

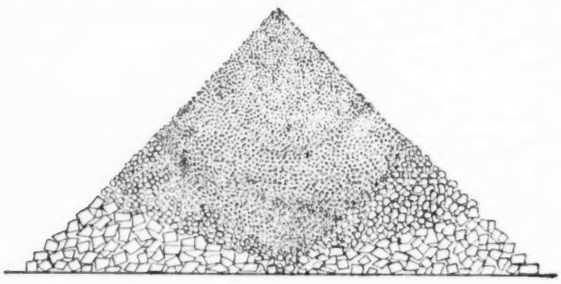


Fig. 4—Diagram shows how not to pile coal

rolled and packed, air circulation is prevented and the danger of fires is practically eliminated.

The effect of storing coal in layers is illustrated by Fig. 5, which shows the proper method, as compared with Fig. 4, which is a more common, but improper method. Figs. 1 and 2 show the equipment used for unloading coal from cars, placing and rolling it with a tractor. Fig. 3 shows a pile of coal over 20 ft. high, stored by this method, which had been in storage, at the time the picture was taken, for over twenty-six months without any indication of fire. The compactness of the pile is shown by the fact that it is possible to drive a motor car directly up the side of the pile.

In addition to the methods of storing, another interesting study for those buying large quantities of coal to study, is the price variation curves, which may be found in many economic papers. In any year or any period of years from 1913 to date, from these curves can be determined, with use of other information regarding economical studies of the country, why the price of coal reaches these seasonal and periodical peaks.

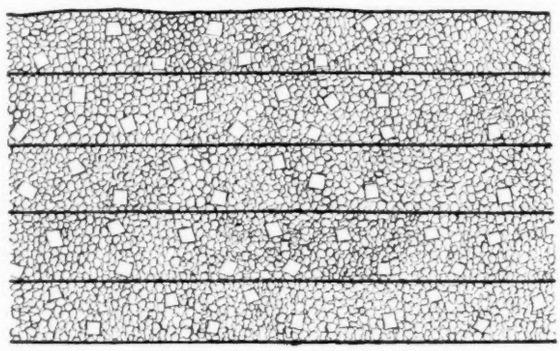


Fig. 5—Diagram of coal piled in layers to avoid fires

By storing coal the seasonal peak can be cut down, and if sufficiently large storage is maintained, the peak caused by various economic conditions also can be very much reduced. One of the difficulties encountered in storing large amounts of coal is fires in the pile, but this can be practically eliminated if the coal is properly stored.

In writing this article the main idea was not to lay down absolute rules as to what should be done, but to create interest in the minds of those, both in executive and operating ends, in organizations using fuel, particularly bituminous coal, a desire to eliminate as far as possible the fire loss which every year amounts to many thousands of dollars.

Cooling water for cylinder jackets, cylinder heads and intercoolers should always be turned on before the compressor is started. In case of stage compression the Compressed Air Society states, the greatest efficiency is obtained with the outlet water from the intercooler at a low temperature. The water supply to air cylinders and intercooler should be independent of each other and the flow controlled by a valve on the inlet. Always use city water when possible. Avoid using dirty water, as it clogs the water jacket and reduces cooling efficiency. Don't forget to shut off water when the compressor is stopped and also open all jacket drains in freezing weather. Outlet water should flow into open funnels allowing frequent temperature readings to be made, a rise in temperature indicating deficient cooling, carbonized discharge valves or leaking piston rings. The use of the thermo-siphon cooling system is not recommended.

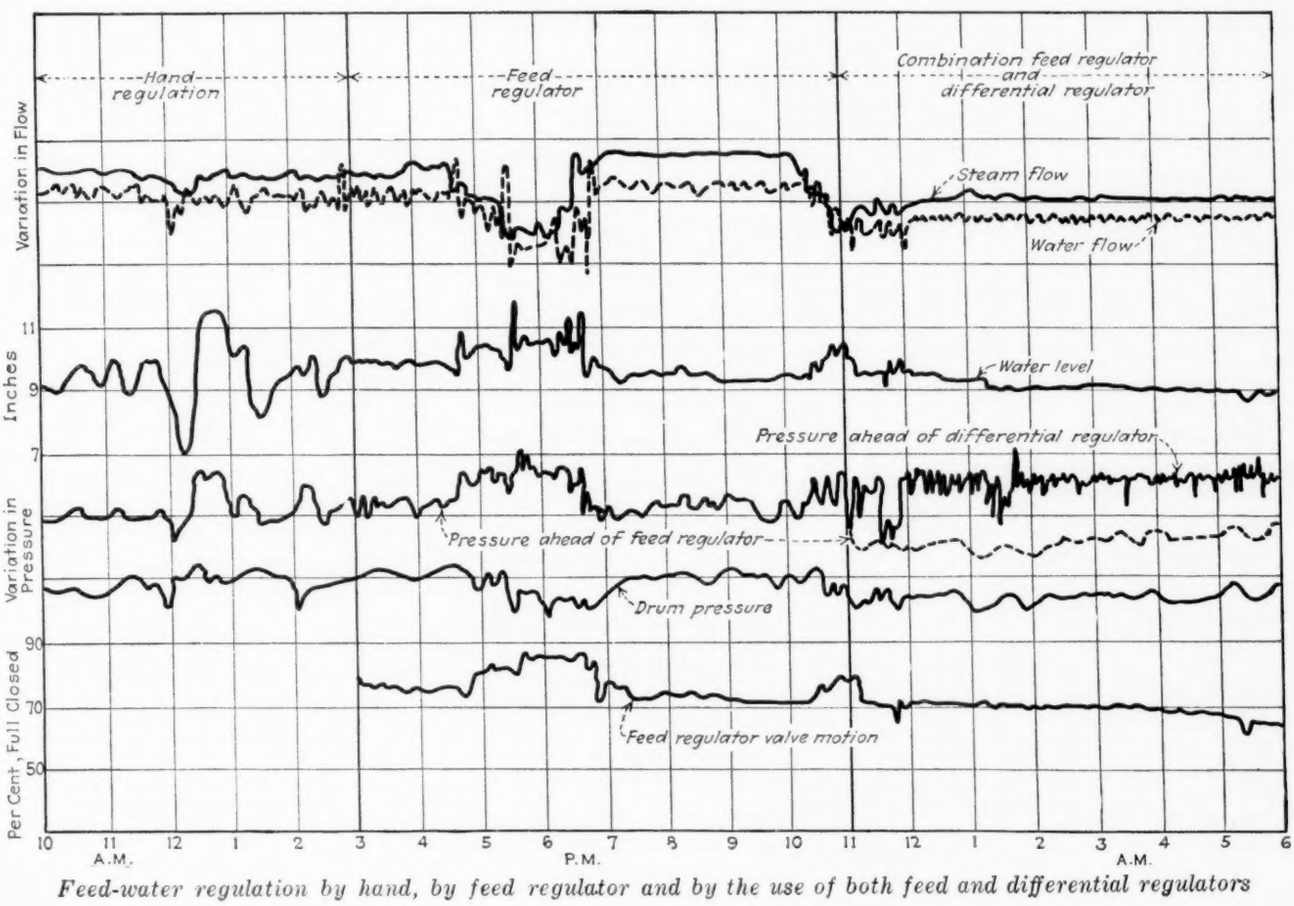
An investigation made some years ago would indicate that a large number of starting compensators used on squirrel-cage motors are connected to the highest tap in order to be able to start the motor under all load conditions. If, for instance, a motor will require as an average 70 per cent voltage to start, the compensator will have to be connected to the highest tap, which very likely will be 85 per cent. Under such conditions the current taken from the line may even be higher with a compensator than with a resistance-type starter.

Crawford Ave. Tests Prove the Value of Constant Pressure Differential in Feed-Water Regulation

WITH the rate of boiler operation increasing and relative drum capacity becoming less, the maintenance of the water level is of growing importance and more difficult. A series of tests made at Chicago's newest station show the advantages of maintaining a constant pressure differential across the feed-water regulator, so that having but one variable to contend with, it will more closely maintain the feed in accordance with the steam demand.

THE tendency to increase the rating at which boilers are operated in order to get the maximum return on the money invested, as well as improved efficiency, has increased the difficulties of feed-water regulation. The increases in steam pressure have resulted in smaller boiler sections and drums which, along with the increase in rating, have reduced greatly the amount of water in the boiler itself, as well as in the drum, when compared with the boiler evaporation. The rapidity of circulation has been increased and the density of the steam as well, so that the actual water level in a boiler is becoming more of an uncertainty with the development of the art. As a result the necessity for continuous water supply to the boiler has become more urgent, and the duties of feed-water regulators for maintaining the proper level have been made correspondingly more difficult. Changes in water level resulting from changes in firing conditions, steam demand, irregularity of boiler feed, or any of the other numerous contributing causes, are exceedingly rapid and the danger of low water or high water is always imminent. Either would be disastrous—low water resulting in damage to the boiler and high water in damage to the prime mover that is being supplied with steam from the boiler. The feed-water regulator must, therefore, operate quickly and positively to maintain a uniform level.

As there has always been more or less difficulty in maintaining a uniform pressure differential between the steam pressure in the drum and the pressure in the boiler feed line, the feed regulators on the individual



Feed-water regulation by hand, by feed regulator and by the use of both feed and differential regulators

boilers have been called upon not only to take care of variations in water level in the drum, but also to take care of fluctuations in differential pressure. The feed regulators did this quite successfully under the old conditions when the volume of water in the boiler was relatively large and changes in level were comparatively slow, but under the present conditions a pressure regulator on the feed line to each boiler is considered advisable in order to relieve the feed regulator of one of its previous duties. A differential pressure regulator at the pump or on the header is not sufficient, as the differential pressure at the individual boiler is affected by the length of the header, the distance of a particular boiler from the pump, by a change in the rate of feeding on some other boiler connected to the header, or by the rate of steaming on the boiler concerned.

Factors Affecting Rate of Flow

In illustration of the foregoing it is known generally that the rate of flow of water through an orifice depends upon the size of the orifice and upon the pressure drop through it. The relation is not quite so simple as that of an electric current through a resistance, but is similar to it. Assume that the throttle valve at the pump is adjusted so that the rate of feeding corresponds exactly to the rate at which steam is generated. If the drum pressure and the feed header pressure remain constant, or more generally, if the difference between these pressures remains constant, the rate of flow will continue constant. However, if any change in either the upstream or downstream pressures—that is, in the drum or header pressures—occurs, the rate of flow is immediately changed, even though the boiler continues to produce steam at the same rate and to receive a constant supply of water. As a matter of fact, these pressures are always changing, so that the water tender has to adjust continually the throttle valve, even though no change in the rate of evaporation has occurred.

It also happens that the rate of evaporation changes, and as this makes a second variable that must be taken care of by adjusting the hand throttle, the amount of tending and work on the part of the water tender is increased.

If, now, the hand throttle is replaced by a feed-water regulator, this device also must contend with two variables—rate of steaming and pressure differences—in order to maintain a constant water level. At a particular rate of evaporation and a certain pressure drop the feed regulator opens a definite amount. The differential ordinarily required to pass the maximum amount of water through a regulator is in the neighborhood of 10 to 30 lb. and the pump pressure is usually adjusted to give about this amount of differential at the boiler.

Assume that the pump pressure is in the neighborhood of 600 lb. and the drum pressure about 550 lb., the total differential being 50 lb., of which probably 30 lb. is consumed in the piping and the difference in elevation between the feed pump and the boiler drum. The remaining 20 lb. differential is available for forcing water through the feed regulator into the drum.

A change of 10 to 20 lb. in either the pump or drum pressure is quite to be expected. Suppose a drop of 10 lb. occurs in the pump pressure, then the pressure at the feed regulator inlet is 10 lb. lower and the differential across the regulator is only 10 lb., instead of 20 lb., as before. The rate of feed into the boiler is reduced, being about 70 per cent of what it was formerly, so that the feed regulator must open rapidly to compensate for this reduction in differential, even though no change in the rate of evaporation has occurred. On the other hand, if the drum pressure decreases 15 to 20 lb., the differential across the regulator is greatly increased, thereby increasing the rate of feeding until the regulator closes down to compensate for this change in differential.

In brief, the feed regulator is called upon to follow not only changes in water level but changes in differential, and what may be a small change in either the drum or pump pressure, amounts to perhaps 100 per cent change in differential pressure across the feed regulator. It is quite to be expected that better results will be obtained from this device if the differential can be held exactly constant, so that the valve opening will depend only upon the rate of evaporation. The work required of the feed regulator then will be approximately one-half that demanded in the ordinary case.

Effect upon Efficiency

While it is important that the water level in a boiler be held within safe limits, a constant water level in itself has no particular effect on the efficiency of the boiler. However, a constant level means that water is being supplied at the same rate steam is produced, which has a direct bearing on efficiency; inasmuch as irregular feeding results in irregular temperatures of water from the economizer or water-heating surfaces of the boiler and consequent changes in evaporation and steam pressure.

Results of tests that recently have been conducted at the Crawford Avenue Station of the Commonwealth Edison Company show clearly the advantages of a constant differential, as comparison was made directly with hand regulation and with control by the feed-water regulator alone. These tests were made to determine if the differential regulator would maintain a constant difference in pressure, and if so, whether the results obtained in control of water level and the rate of flow into the drum would justify the additional expense and complication. The accompanying chart, which is self-explanatory, is the answer. It is evident at a glance that the water conditions in the boiler under combined pressure regulation and feed regulation are almost ideal. The comparative results indicate the value of a differential regulator in connection with each feed regulator.

It would seem that if such marked improvement has been obtained, with a steaming rate as nearly constant as can be maintained in a large boiler, with control of the stoker speed and draft, with expert attention and with as nearly constant steam pressure as can exist in a base-load station with close regulation at the pump, a still greater improvement may be expected in plants where the load and the steam pressure are continually varying.

A better control of feed is undoubtedly the cause rather than the result of the uniform steam pressure and steam flow shown by the chart during the third period.

For Checking Thermometers a second well should be installed close to the well or bulb of the service thermometer and should be placed along the line of flow of the fluid to assume equal temperatures of the two wells.

Virginian Railway Adopts Pulverized Coal for Widely Fluctuating Load

IN the new station located at Narrows, Va., the initial installation includes five 15,210-sq.ft. cross-drum boilers and four 10,000-kw. generating units. Flexibility of operation was a deciding factor in the use of pulverized coal as fuel. The preparation equipment is located beside the boilers. The plant supplies power for haulage of coal trains over the Allegheny Mountains. Swings in load approach 16,000 kw.

FLEXIBILITY of operation, quick pick-up of load and elimination of banking losses were some of the factors that dictated the adoption of pulverized fuel as the method of firing the boilers at the new plant of the Virginian Railway Co. at Narrows, Va.

The new plant, which went into service a few months ago, supplies power for the haulage of coal trains over the electrified section of the railroad extending from Mullen, W. Va., to Roanoke, Va., a distance of 134 miles, and includes the heavy-grade portion of the road where it crosses the Appalachian Mountain Range. Owing to the size of the train units and the tonnage carried, the concentration of power is probably the heaviest ever undertaken on a moving train.

As the nature of the service demands that the plant operate on a widely fluctuating load, the swings at times approaching 16,000 kw., it was essential that some method of firing be used where, not only a quick pick-up of load was possible, but there would be only a small quantity of fuel in the furnace at any one time, to obviate excessive blowing off of the boilers when the load suddenly dropped. As the plant is situated in the coal-mining district, pulverized coal appeared to meet the requirement of the station.

The location of the plant on the New River, at Narrows, meets the fundamental requirements with regard to circulating water, fuel supply, nearness to center of load and convenience for housing the operating force in an established community.

The initial installation includes four three-phase 11,000-volt 25-cycle turbo-generator units, having a continuous rating of 10,000 kw. at 80 per cent power factor, with five 15,210-sq.ft. boilers, equipped to burn pulverized fuel. The power house is designed to permit of extension ultimately to include seven turbo-generator units and nine boilers.

The power-plant building is constructed of brick and concrete with structural-steel columns and floor beams, and with roof of special heat-insulating concrete slabs covered with zinc shingles. The boiler room is 217 ft. long, 62 ft. wide and 91 ft. in height, giving room for six boilers, five of which are installed. The boiler ash-pits, pulverizing mills and feed-water heaters are at ground level. A mezzanine gallery, 23 ft. above the lower floor, provides space for the pulverizer exhausters, the primary air fans and future coal-drying units. A mezzanine gallery at the rear of the boilers 12 ft. above the main operating floor provides access to the rear of the boilers for the removal and replacement of tubes. The ground area occupied by the boiler house building is 13,500 sq.ft., or 0.148 sq.ft. per square foot of boiler-heating surface, and 0.34 sq.ft. per kilowatt of generator rating. The boiler house contains 32,800 sq.ft. of floor area, or 0.36 sq.ft. per square foot of boiler-heating surface and 0.82 sq.ft. per kilowatt, all allowances including space required for the pulverizing units. The floor area of the turbine room is 11,500 sq.ft., thus providing 0.29 sq.ft. per kilowatt.

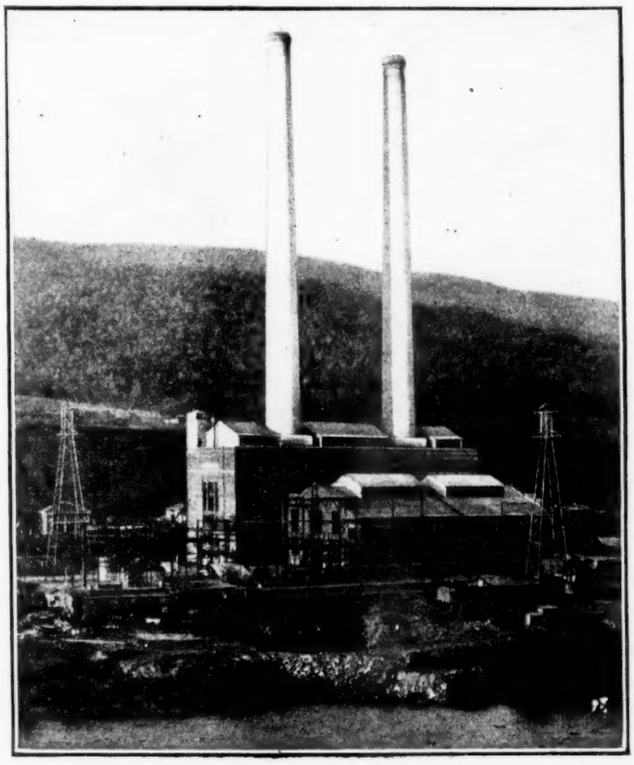


Fig. 1—View of Narrows Plant from across the New River

As the turbine-room basement floor is only 3 ft. above low-water level and records show a flood stage of 33 ft. above the basement floor, substantial walls and floor are provided to take care of this hydrostatic head; the walls being of reinforced concrete 2 ft. 9 in. thick with dovetailed construction joints. The horizontal reaction at the top of the walls against the hydrostatic head is obtained by bearing against the heavy slab of the floor. To provide anchorage for the floor slab against the hydrostatic pressure, it is reinforced and spans across between heavy concrete ribs, running between piers of the turbine foundations, against

which it is expected it will react upward.

The turbine bedplates are supported on steel girders and columns filled with concrete, which rest upon concrete piers running down to rock a few feet below the basement floor and being braced by concrete walls. The steel turbine foundations are framed solidly into the floor framing and strutted to each other by floor girders in order to develop the inertia of the heavy floor slabs as a steadying influence upon the turbines.

The plant has been designed for the use of "bone" coal, with provision for burning the high-grade bituminous coal from the mines served by the Virginian Railway Co. or a mixture of the two. It is expected that the total annual net output of the plant will be approximately 120,000,000 kw.-hr. and that the average daily fuel consumption will be approximately 390 tons of "bone" coal, or 275 tons high-grade bituminous, or 320 tons of a 50 per cent mixture.

A coal siding is provided for storage of 25 to 30 cars leading to a track hopper, which will receive coal either directly from cars or from outside storage by use of a power hoe.

Preparation Equipment Adjacent to Boilers

Coal passes from the hopper through a reciprocating feeder onto an inclined-belt conveyor and over a magnetic pulley into a crusher, and thence into a hopper fitted with an automatic skip-loading device and hoist which elevates the crushed coal and discharges it into a hopper at the top of building, which feeds either into a flight conveyor distributing the coal to six bunkers or into a chute leading to outside storage. The coal-handling equipment is designed for a capacity of 85 tons of coal an hour.

The pulverizing mills which are on the lower boiler-room floor, are of the impact air-separation type equipped with a pneumatic feed control. Each unit has a relief pipe through the roof, fitted with an explosion door, and also a vent pipe leading to atmosphere through a water spray and collection chamber, arranged to prevent any coal dust from passing out of the system.

Two screw conveyors are installed between the dust collectors and the pulverized-coal bunkers, so arranged

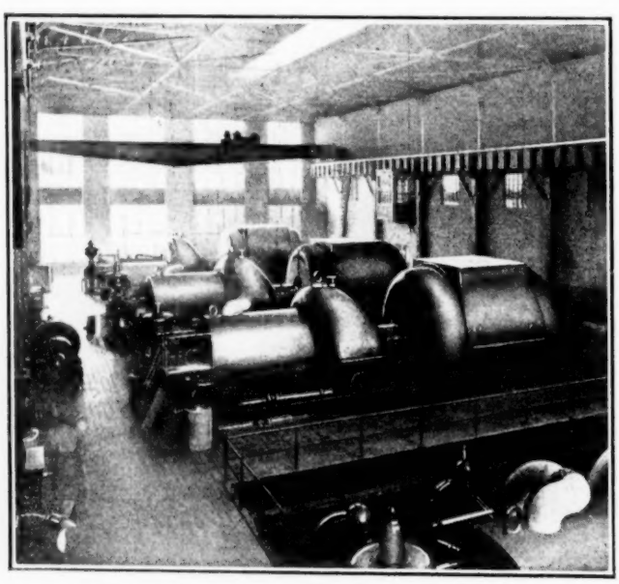


Fig. 2—Turbine room with three of the four 10,000-kw. units

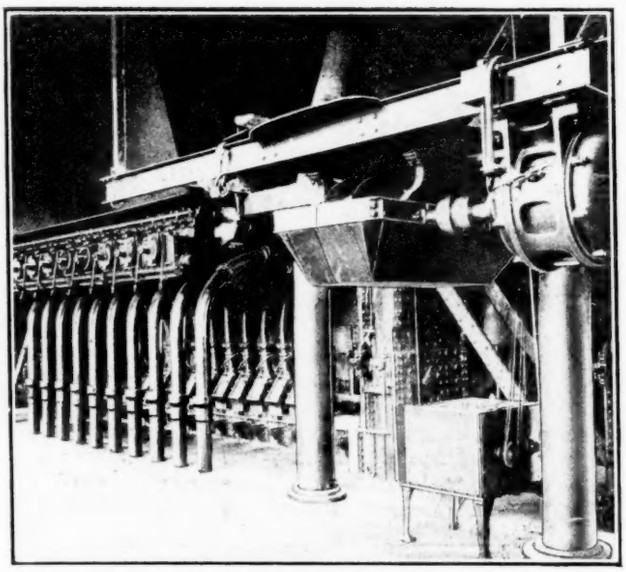


Fig. 3—Boiler operating-floor level showing feeder and burner arrangement

that pulverized coal may be delivered from any pulverizing unit into its bunker without operating the conveyors, or from any pulverizing unit into any of the bunkers by the use of either or both of the conveyors. Each pulverized-coal bunker is vented. The coal conveying pipe, dust collectors, vent pipe from bunkers, the sides, ends and tapering bottoms of the bunkers are insulated with magnesia blocks to prevent condensation. All parts of the equipment are electrically interlocked so as to assume proper functioning.

Boilers Are Cross-Drum with Interdeck Superheaters

The boilers are Springfield cross-drum, built for 325 lb. pressure. They are arranged in a single row, with independent settings. Each boiler has a 1,770-sq.ft. inter-deck superheater designed to give 150 deg. superheat with the boilers operating at 160 per cent of normal rating. The boilers are baffled to expose the lower six tubes to the radiant heat of the furnace.

Water screens are provided in the bottom of the furnace to prevent formation of slag and to allow operation with high CO_2. It is expected that the heat absorption on the screen tubes will be from 30,000 to 50,000 B.t.u. per sq.ft. of surface.

The pulverized fuel is introduced into the furnaces through 10 Lopulco burners mounted vertically in the top of the furnace. Primary air is supplied at the feeders, the balance of the air needed for combustion being induced by natural draft around the burner and through the air inlets at the front of the furnace. A Bailey meter control is installed for automatic regulation of the boiler furnaces.

The main turbines are Westinghouse parallel-flow type, operating at 1,500 r.p.m. at 275 lb. steam pressure and 150 deg. superheat at the throttle. They are guaranteed for a maximum economy of 12.48 lb. of steam per hour, when delivering 10,000 kw. at 80 per cent power factor, and with a vacuum of 29 in. The generators are designed for a continuous full-load rating of 12,500 kva. at 80 per cent power factor, and will carry, following continuous full-load operation, a load of 15,000 kva. at 80 per cent power factor for one

hour, and 18,750 kva. at 80 per cent power factor for five minutes following the operation at 16,000 kva., without exceeding a safe operating temperature. A 125-kw. 250-volt direct-connected exciter is mounted at the end of each generator. One 300-kw. auxiliary turbo-

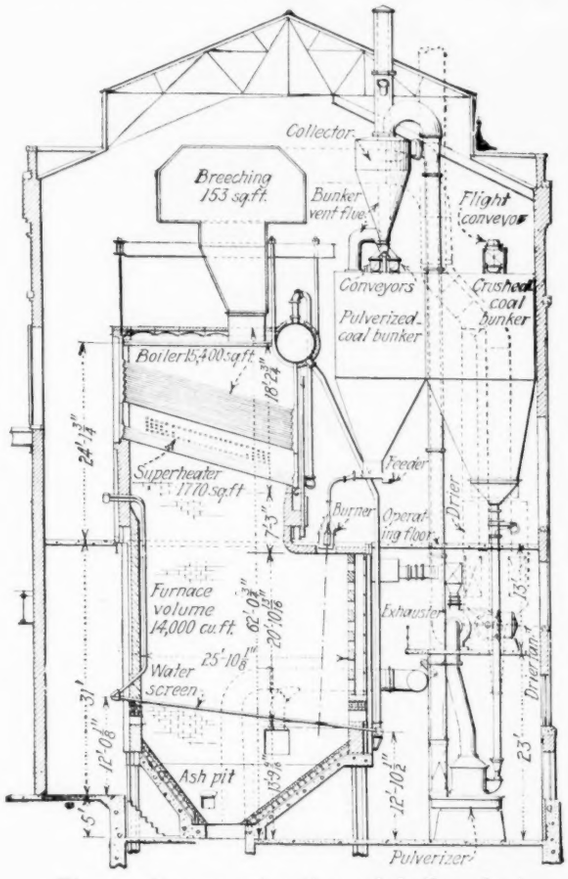


Fig. 4—Cross-section through boiler plant

generator is also provided. The auxiliary turbine is of the impulse type and it connected through a reduction gear to a three-phase 440-volt alternating-current generator, a 100-kw. 250-volt direct-current generator; and a small direct-current generator supplying excitation to the alternating-current machine. The 440-volt alternating-current generator supplies power for the operation of the auxiliary equipment during the starting up of the plant, and is available for special service during the regular operation. The 100-kw. direct-current generator is provided to supply excitation to any one of the main units in the event of failure of the direct-connected exciters.

Generator Cooling Air Is Discharged to Boiler Room

For cooling the generators, 78,000 cu.ft. of air per minute is required. This is supplied by vanes on the generator rotors. The air is drawn through air filters of the oil impregnated type and, after passing through the generators, is discharged into the boiler room directly back of the boilers, thus furnishing heated air to the furnaces.

The condenser serving each unit is of the two-pass type with an effective cooling surface of 20,000 sq.ft. Circulating water is supplied through an intake tunnel from the upstream side of the plant and passed through water screens into an intake tunnel under the turbine-room basement, from which it is drawn by the centrifugal circulating pumps.

Air is removed from the condensing system by two-stage air ejectors, three ejectors being provided for each pair of units, so arranged that any of the three may be used on either unit. Each ejector is of ample capacity for removing the air from the systems when operating at vacuums of 28 to 29 inches.

Feed-Water System Includes Bleeder Heaters

The feed-water system consists of bleeder heaters at each of the turbines, two open water heaters, three turbine-driven boiler-feed pumps and a loop system of boiler-feed piping between the pumps and the boilers. The bleeder heaters are of the closed type, each having a capacity of heating approximately 200,000 lb. per hour through a temperature range of 100 deg. The condensate from the condensers is passed progressively through the air ejectors and the bleeder heaters and, together with that from the bleeder condensate pumps, discharges either into the open feed-water heaters or into a surge tank. This tank is subdivided by a partition into a treated-water storage tank and a surge tank. The surge tank provides for the storage of the condensate resulting from a 20,000-kw. load for a period of five minutes even if no water is fed to the boilers. The storage tank supplies the makeup water required for the system, and when full, it will handle a swing of 22,200 kw. for four and one-half minutes even if no condensate from the condensers is available. A float valve allows the admission of makeup water to the storage-tank through a water-softening plant.

Two open feed-water heaters are provided, each having a capacity for passing and heating 350,000 lb

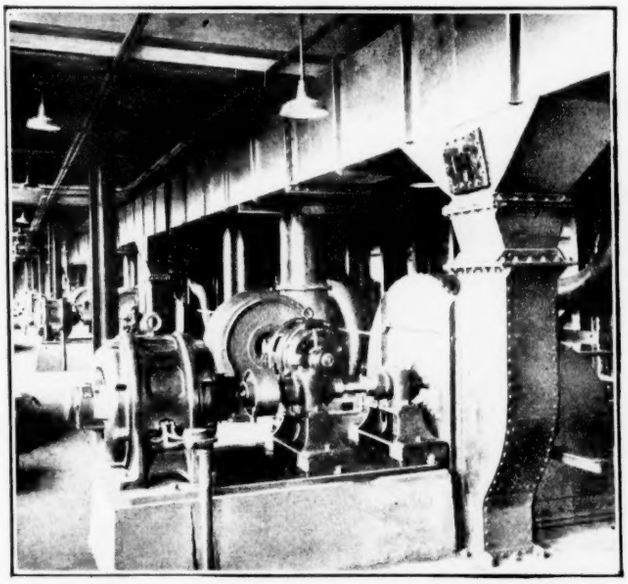


Fig. 5—Primary air fans and mill exhausters

of water per hour to a temperature of 225 deg. or 700,000 lb. per hour, through a somewhat lower temperature range. This capacity will allow the operation of four boilers at over 380 per cent of rating.

Three high-pressure steam systems have been provided, one furnishing steam at boiler-drum pressure and saturated steam temperature; the second furnishing steam at boiler-drum pressure and 150 deg. super-

heat, the total temperature of which is approximately 580 deg.; and the third furnishing steam at 175 lb. pressure and 180 deg. of superheat, the total temperature of which is approximately the same as the high-pressure superheated steam.

Current is generated at 11,000 volts three-phase and stepped up through four 10,000-kva. transformers to 88,000 volts for single-phase transmission. One phase of each generator is connected to the primary of the step-up transformers, the connection being arranged for normally operating each generator and corresponding transformer as a unit. A three-phase 11,000-volt bus is provided for synchronizing and supplying power to the station auxiliary transformers. The electric locomotives used on the system are of the split-phase type in which the 12,000-volt single-phase power from the trolley is stepped down through a transformer on the locomotive and converted to three-phase for the traction motors by means of a synchronous phase converter. This type of locomotive provides automatic change from motoring to regeneration, as the grade changes without action of the engineman other than a movement of a lever operating the transformer balancing switch. The regenerated power is returned to the substations and finally to the power plant, where excess power is absorbed by a water rheostat consisting of electrodes immersed in the river.

The power plant was designed and constructed by Gibbs & Hill, consulting engineers, of New York City, under the general supervision of H. Fernstrom, chief engineer of the Virginian Railway, and Hugh Pattison, engineer of electric traction.

Cause of Air Compressor Corrosion

By Charles H. Bushnell

Trouble at times is experienced with corrosion of Diesel air lines and cooler coils. Some claim that this results from the existence of sulphur oxides in the atmosphere, formed during combustion in the engine cylinder. Although many Diesel engineers agree that sulphur can have no destructive effect on exhaust valves and cylinder liners, they blame the corrosion in the air lines on the sulphur dioxide (SO_2).

Copper cooling coils are subject to attack from the air side. Thinning occurs mostly at the outer radius of the coil or any short bends. The injection air header or fittings and parts of the fuel valves may be attacked. No doubt a sufficient amount of SO_2 would be destructive to metal, but it seems that it would be even more so to the engineers' lungs. Of more importance, there may be corrosion whether or not there is sulphur in the fuel. Now if sulphur is not the cause, what is?

Because of the fact that coils are more affected on the outer radius, it is often charged up to erosion. This is not logical, for if the coils are properly designed the air velocity is not high. Corrosion of the fuel valves is often charged up to the fuel direct. The usual test for determining whether oil is corrosive is to immerse a polished strip of brass or copper for a day or two. If the fuel does not affect the brass mountings of the fuel pumps, it will not affect the fuel valves.

Steam engineers can tell us something of the effect of warm oxygen and water together. With the old-time direct-connected feed pumps on marine engines considerable air was handled by the pump. This proved to be destructive to copper feed lines. Any air or oxygen is considered very undesirable in a boiler. Some authorities claim that a small amount of CO_2 is necessary before there can be any galvanic action. This, however, is immaterial, as there is always sufficient in the normal atmosphere, let alone in an engine room.

Throughout most of the injection-air system there is warm moist or wet air. This would appear to be sufficient to account for the trouble. The reason that the coils are affected most on the outer radius is because erosion removes the film of copper oxide that would otherwise protect the metal. In the injection-air header and fuel valves galvanic action may be accelerated because of dissimilar metals in contact.

One solution is to adopt the steam engineers' method of preventing corrosion. This is to separate the water and air as far as practical or, where this cannot be done, to use zinc plates. It is worth while to cite an example of fuel-valve corrosion in connection with this. The neck-bushings under the packing were of brass containing a high percentage of zinc. These wasted away and had to be replaced in about a year. As an experiment a more resistant metal was tried. This was not affected, but the needles that had remained bright up to this time, turned black and began to pit. The low-grade brass was again used and the needles again remained bright. It is also of interest that this engine has been running for over three years without the needles being ground in or giving the slightest trouble from leaking.

While this was effective, a more logical method of protecting the injection header and the fuel valves would be to dry the air. If the air were passed through a good separator, similar to a steam separator, after leaving the aftercooler most of the water could be taken out. This alone would not be sufficient, as there is usually some further cooling, causing more condensation. Reheating to a moderate temperature would be necessary, but this is easily done with exhaust gases and it would also make some saving in injection-air consumption.

In the coolers the air cannot be kept dry, but zinc could be used to advantage if the engine builders were to make provision for it. Cast would be preferable to rolled zinc because of the tendency of the latter to flake.

Sulphur Dioxide is a refrigerant whose machinery requires careful selection of the lubricant. Only the highest grade of mineral oil can be used, for like some other low-pressure chemicals, sulphur dioxide has a decided affinity for certain of the hydrocarbon components in mineral lubricants. It is entirely possible to treat mineral oils of medium viscosities to remove the component parts affected by sulphur dioxide and render the residual oil quite satisfactory as a lubricant. In certain systems provision is made for removal of any lubricant that may have entered the system, by means of a suitable return line. In others, oil traps or separators are employed in much the same manner as in an ammonia system. Location of the evaporator or refrigerating side of the installation on a higher level than the compressor will permit of drainage of the lubricant back to the latter if it is present in either the coils or suction line.—*Lubrication.*

Steam at a Pressure of 459 lb. per sq.in. absolute has a temperature of 459 deg. F.

Where To Bleed a Turbine

By W. G. LAUFFER

FROM how many stages should steam be bled to heat feed water? Which stages will give the best economy? The author shows how this question is answered by calculations, and presents curves showing typical results to guide the plant designer.

BLEEDING steam from turbines for feed-water heating has been employed extensively during the last few years. This has been due, in a large measure, to the installation of numerous large turbine units designed to operate under base-load conditions with as high average thermal efficiency as can be attained.

It has long been known that bleeding for feed heating results in considerably improved economy. However, there are several questions in connection with bleeding steam for feed-water heating, the answers to which are not readily found. Exactly how much gain, due to extraction, may be expected? How many stages of bleeding should be used? At what pressures should the bleeding be effected?

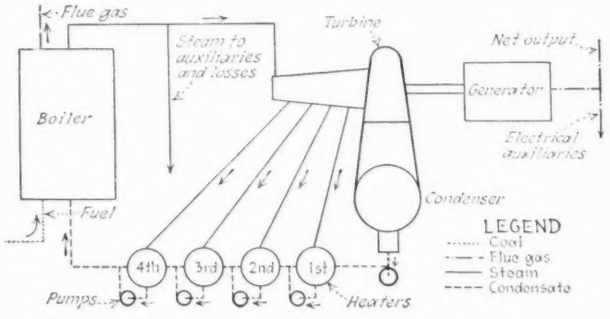


Fig. 1—Heat balance layout for four bleed points

The results of a study to determine the answers to these questions are given in this article. The study was limited to extraction of steam for feed heating only, and no attempt has been made to consider the possibilities of utilization of bled steam for evaporators, steam jets, soot blowers, etc.

It was also thought advisable to investigate the possible existence of any definite general relations that would permit application of the results found to similar problems in extraction for feed heating, even though the initial conditions might not be exactly the same as those used herein.

In order to have a concrete case on which to base the calculations, the following conditions were assumed:

Load, kw.	50,000
Capacity of unit, kw.	50,000
Throttle steam pressure, lb. per sq.in. gage	375
Throttle steam temperature, deg. F.	692
Turbine back pressure, in. of mercury, absolute	1
Boiler efficiency, per cent	77.5
Power for auxiliaries (electrical), per cent	7
Power for auxiliaries (steam), lb. per hour	10,000

The assumed throttle steam conditions were taken as representative of average modern practice. Auxiliaries, including coal and ash handling, were assumed to be mainly electrically driven. The steam for auxiliaries, 10,000 lb. per hour, was taken to include steam for soot blowing, steam jets, all auxiliaries not electrically driven and also condensation and leakage. The boiler efficiency was taken as representative of a well-operated stoker-fired boiler plant having neither economizers nor air preheaters.

To simplify the calculations, it was assumed that the condensate from each closed heater was returned to the feed line on the discharge side of that heater, as illustrated in Fig. 1, which shows the layout for four bleed points. It is obviously not the best practical arrangement inasmuch as it would necessitate a small high-pressure heater condensate pump for each heater. However, since the same design was assumed throughout, the results are directly comparable. Moreover, the difference in economy attainable with various heat-balance layouts for a given number of bleed points is but a small percentage of the total economy. In other words, using the assumed heat balance rather than any other layout has impaired the accuracy of the absolute values but slightly and that of the relative values practically not at all.

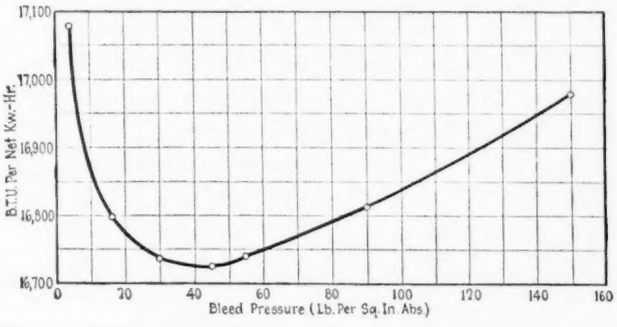


Fig. 2—The heat rate varies with bleeder pressure for single extraction

The procedure followed in determining the expected economy under bleed conditions may now be briefly outlined. For simplification, the case of one bleed point is considered.

Having the steam temperature and pressure at the throttle determined and assuming for the time being that the pressure at the bleed point is known at the load being considered, it is first necessary to calculate the heat converted into work due to adiabatic expansion of the steam from the throttle conditions, down to the pressure at the bleed point. The use of the Mollier diagram will greatly facilitate this step in the calculations.

Next, the heat drop during actual expansion is found by multiplying the theoretical heat drop by the engine efficiency. This gives the actual heat converted into work, and the bleed water rate, the quality or superheat of steam at the bleed point, the pressure and temperature of the bled steam at the heater and the heat available for heating feed water may all be readily computed. Assumption of the heater terminal difference will then permit determination of the temperature of the feed water on the outlet side of the heater. The straight condensing water rate of the turbine must also be computed again, using the Mollier diagram and the corresponding engine efficiency.

The next step is to determine the amounts of steam bled and supplied to the throttle, together with the temperature in the feed line after the point at which the heater condensate is returned. The use of equations solved simultaneously will permit determination of these quantities.

The character of the equations will, of course, be governed by the nature of the heat-balance layout. Their formulation will necessarily be based on various

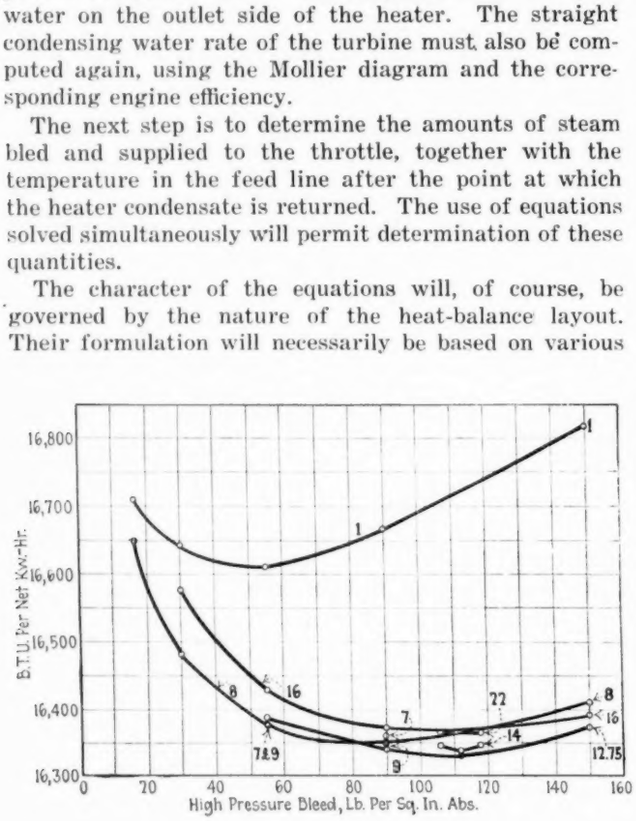


Fig. 3—With two bleeder points the situation is more complicated

The numbers adjacent to the curves indicate the low-pressure bleeding point, in pounds per square inch absolute, for which the respective curves are drawn.

known thermodynamic laws embodying interchanging of heat in the heaters, work done by expansion of steam down to the bleed point and down to the back pressure in the condenser, etc. However, the fundamental consideration to be kept in mind is that the equations are simply statements of fact as to what actually takes place in the system, expressed mathematically.

From the amount and the heat content of the steam supplied and bled, the turbine thermal efficiency and over-all net station economy (including boiler efficiency, auxiliaries and losses) are readily found.

To determine the increase in economy with varying numbers of bleed points, it is first necessary to determine the maximum economy obtainable with any definite number of stages of bleeding. It is, of course, readily understood that for any given number of bleed points there exist definite pressures at which the bleeding should be effected for maximum economy.

In the preceding discussion of the method of solution employed, it was assumed that the bleed pressures were known. One of the aims of this study was to determine where the bleed points should be located for maximum economy. Consequently, at the start, the most economical bleed pressures were unknown and recourse to the method of trial and error was the alternative.

The condition of one bleed point provided the least trouble, inasmuch as this case presented the fewest unknowns. The bleed pressure was varied in successive increments from 4 to 150 lb., and the station economy for each bleed point location was determined. A curve,

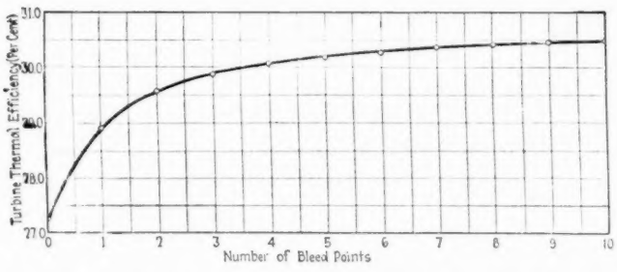


Fig. 4—The best attainable thermal efficiency increases with the number of bleed points

as shown in Fig. 2, showing the relation between economy and bleed pressure was then drawn and the low point on the curve determined. And so ended the work as far as one bleed point was concerned.

For two bleed points the lower pressure bleed pressure was held at various values, while the higher bleed pressure was varied and the heat rate for each of the cases was found. The result of this set of calculations is shown in Fig. 3. The number of trials necessary prior to determination of the combination productive to maximum economy was, of course, considerably increased, owing to the two variables involved.

When considering three bleed points, it was necessary

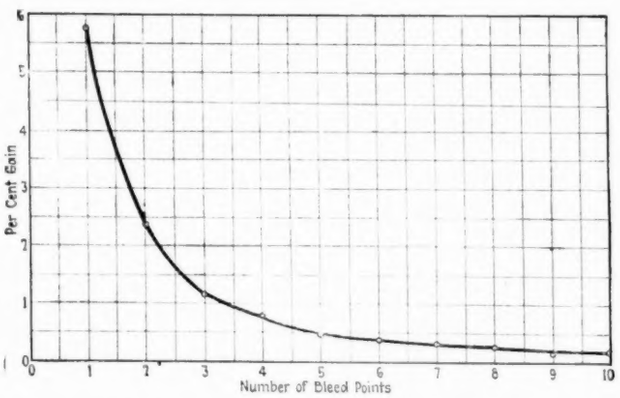


Fig. 5—The percentage gain in over-all net heat rate for each added bleeder heater decreases rapidly

For example, 3 heaters give 1.2 per cent better heat rate than 2 heaters, while 8 heaters show a gain of only 0.3 per cent over 7 heaters.

to maintain two of the bleed pressures constant and vary the third, etc.

Fig. 4, obtained from the results of this trial-and-error method of solution, shows the maximum attainable economy for any given number of bleed points. Fig. 5 shows successively the percentage increase in total economy for a given number of bleed points over the preceding number. Inspection of these two curves shows that it is doubtful if the savings to be realized by going to more than five stages of bleeding will equal

the additional costs due to maintenance and carrying charges incident to the added equipment required.

Exact determination of the most economical number of bleed points is, of course, a separate and distinct problem for each individual installation. Any possible savings in terms of dollars and cents are largely affected by the load characteristics. For this reason no attempt has been made to draw any conclusions other than the general statement relative to the most economical number of bleed points.

The curves in Fig. 6 give, indirectly, the pressures at which to bleed for maximum economy with any given number of stages of bleeding for feed heating. Inspection of these curves will show that the temperature is apparently the governing factor. For instance, it will be noted that a horizontal section through any number of bleed points is cut by the curves in equal increments.

Furthermore, the curves obviously have two asymptotes, one being the saturation temperature of the back pressure and the other being the saturation temperature of the throttle pressure. Since the vacuum is fixed within very close limits, the corresponding asymptote is definitely determined regardless of initial temperature and pressure, etc. At the throttle pressure

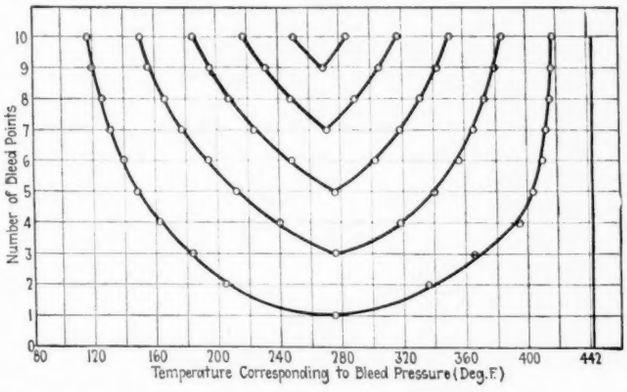


Fig. 6—Best efficiency results from bleeder pressures that split the temperature range into equal steps

assumed (375 lb. per sq.in. gage) a variation of 10 lb. pressure, plus or minus, results in a change in saturation temperature of but 2.5 deg. F. Moving the upper limit asymptote slightly either up or down will have a negligible effect on the location of the curves. In other words, although the curves were derived under conditions of a constant throttle pressure of 375 lb., they are correct, for all practical purposes, for throttle pressures considerably above or below the assumed condition.

The curves in Fig. 6 for predetermining the most economical pressures at which to bleed, make problems in feed heating with extracted steam relatively short and straightforward.

Fig. 6 also shows, indirectly, the most economical temperature to which feed water should be heated, for different numbers of bleed points. It will be noticed that the extreme right-hand curve gives the most economical saturation temperature of the highest pressure heater. By subtracting from this temperature the terminal difference of the heater, the economical feedwater temperature is obtained. Of course the terminal difference of the heater depends upon its size, and proper selection demands a study of heater cost and heat saving.

Automatic Hydro-Electric Plant Serves Dual Purpose

An automatic hydro-electric generating station soon to be installed by the Bibb Manufacturing Co., a textile plant at Porterdale, Ga., will be designed to operate in parallel with the Georgia Railway & Power Co. system, will generate power for the Bibb plant and will improve poor power-factor conditions at this point. The type of control used will be the first of its kind to be put in operation in this country.

The equipment will include two vertical waterwheel-driven generators rated 1,500 kva., 750 kw. at 2,300 volts; three 38,000 to 2,300-volt transformers, and a complete automatic switchboard. All the electrical equipment will be furnished by the General Electric Co. who developed the method of operation.

The water power was formerly used to furnish mechanical power from horizontal wheels, and this old station will now be shut down. In tieing in the automatic generating station with the public utility system, the 2,300-volt bus will be connected to the 38,000-volt system through the three single-phase transformers connected delta-delta.

With the object of supplying as much leading or corrective current to the system as possible, a constant-current regulator will hold the full load of 1,500 kva. on the generators, in contrast to the usual practice of maintaining constant voltage. It is expected to improve the plant power factor by this method from 77 per cent to approximately 85 per cent.

Power for running the Bibb plant will come from the public utility lines in parallel with the automatic generating plant. The two hydro-electric generators will operate automatically in sequence and will be governed by a float switch located at the forebay. At the minimum water level, one machine only will run, its entire output being made up of 1,500 kva. leading, thus having a maximum corrective effect on the system. As the water level rises, the energy load on the generator will increase and the supply of leading kva. will decrease until, at the maximum load point, the 1,500 kva. output will be made up of 750 kw. actual energy at 50 per cent power factor, thus leaving 1,300 kva. for corrective purposes.

When the first machine has been loaded to its rating, the second generator will automatically start and go through the same load cycle as the first machine until, provided the water level rises sufficiently, the two machines will be furnishing a total output of 3,000 kva. consisting of 1,500 kw. actual energy at 50 per cent power factor and leaving 2,600 kva. for corrective purposes. Thus, during low-water periods the prime movers will furnish as much energy current as the available water supply will allow and, at the same time, will always furnish leading current for improving the plant power factor. The machines will run automatically under all normal conditions and will shut down automatically in case of trouble.

A 60-Watt Tungsten Lamp with 90 per cent rated voltage impressed on its terminals, will produce about the same amount of illumination that a 40-watt lamp will when operating at rated voltage. When a tungsten lamp is subjected to 10 per cent increase in voltage continuously, it will result in a life reduction of about 50 per cent.

Operation and Adjustment of A.-C. Elevator Brakes

Problems Involved in Obtaining Satisfactory Alternating-Current Elevator Brakes—Operation and Adjustment of Three Different Designs

By HOWARD B. COOK* and F. A. ANNETT†

DESIGNING an elevator brake mechanism is a problem quite different from that of designing brakes for other purposes. The time required for operation or the force of application is not usually of great importance in brakes, but each of these factors is an outstanding feature in elevator service. An elevator brake should be so designed that it can be applied in about one one-hundredth of a second.

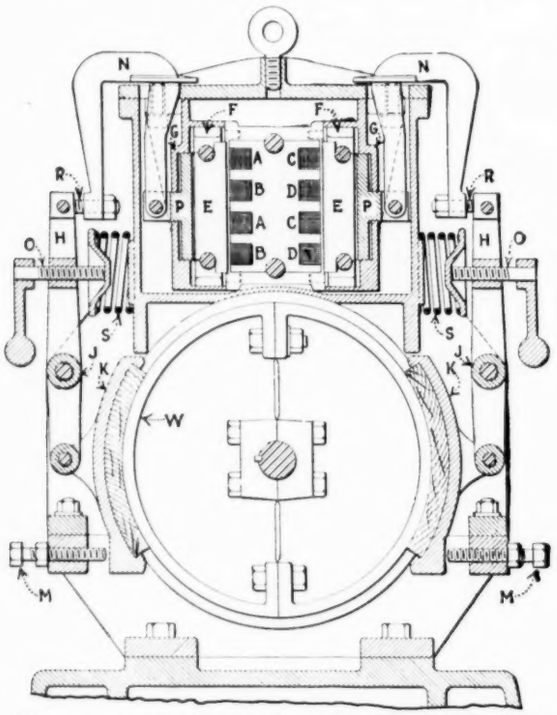


Fig. 1—Cross-section through the brake, Fig. 2

If an elevator is operated at a speed of 180 ft. per min. (3 ft. per sec.) it will travel one inch in $\frac{1}{3}$ of a second. With an elevator at this speed a good operator will frequently make stops within an inch of the floor if the brake is responsive. This means that the total error in his judgment in determining the proper place to move the car switch to center does not exceed $\frac{1}{36}$ of a second. There are quite a number of single-speed alternating-current elevators that operate at 180 ft. per min. or faster. At least one installation is operating at 400 ft. per min., without a slow down for stopping.

A feature that is frequently lost sight of in elevator brakes is the force with which the shoes are applied to the wheel. The shoes are released and accelerated to quite a high rate of motion before they come in contact with the wheel, when they are brought to rest almost instantaneously. Stopping the brake shoes so suddenly must cause them to be applied to the wheel with a much higher force than that developed by the tension springs. This will be apparent from the following problem:

To move one pound through a distance of $\frac{1}{4}$ in. in $\frac{1}{100}$ of a second requires a force of 13 lb. If this weight of one pound is then stopped in $\frac{1}{16}$ in., it will produce a force of 42 lb. It is probable that this characteristic

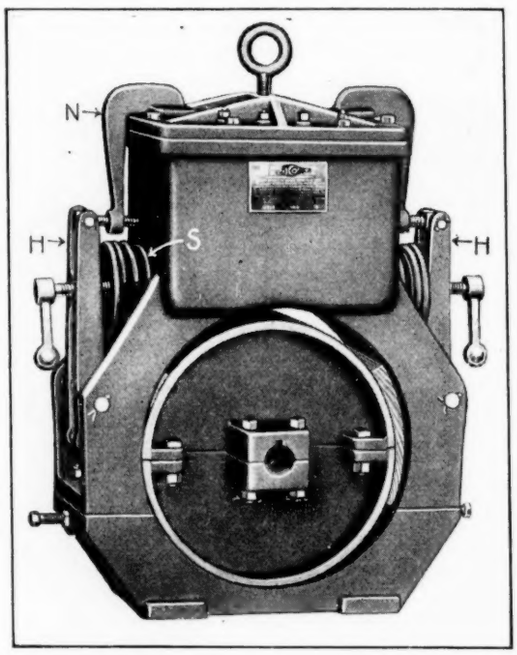


Fig. 2—Polyphase magnet immersed in oil mounted above the brake wheel

is the main cause of the difficulty in adjusting many elevator brakes. They are very sensitive, and if the stroke or pressure is varied but slightly, they will either grip the brake wheel or let it slide. It has been found necessary in some cases to increase the weight of the brake wheel to obtain smooth retardation.

In alternating-current elevator work the design of a satisfactory brake is quite a different problem from that of a direct-current brake. The stopping of an elevator operated by a direct-current motor is done by the use of two brakes, the dynamic and the mechanical.

*Electrical engineer, The Warner Elevator Manufacturing Co., Cincinnati, Ohio.

†*Power* editorial staff.

Dynamic brake action is produced during the stopping period by connecting the motor's armature to a resistance, so that it becomes a generator and offers a retarding force to the elevator's motion. In this way the energy stored in the moving mass is dissipated in the form of heat in the resistance. When the speed of the motor is high, the effect of the dynamic brake is strong, but this effect decreases as the machine slows down and becomes zero when the motor stops. Under these conditions the mechanical brake has very little work to do, its chief function being to hold the car after it has come to rest; therefore the resulting action of the two brakes can be made very smooth.

An alternating-current motor cannot easily be used as a dynamic brake, particularly at low speed, consequently the mechanical brake must be of sufficient capacity to dissipate all the energy due to the motion of the parts of the machine. With single-speed alternating-current motors the mechanical brake must stop the car from full speed. If multispeed motors are used, the motor can be utilized to slow the car down to a speed corresponding to the slow speed of the motor, but below this the mechanical brake must stop the car, consequently the brake on an alternating-current elevator must be considerably larger than for a direct-current machine of a corresponding capacity and speed. An alternating-current motor of the same capacity and speed will have a considerably heavier rotating member than a direct-current machine. This, taken in conjunction with the larger brake wheel, adds to the energy that the brake on an alternating-current elevator must dissipate.

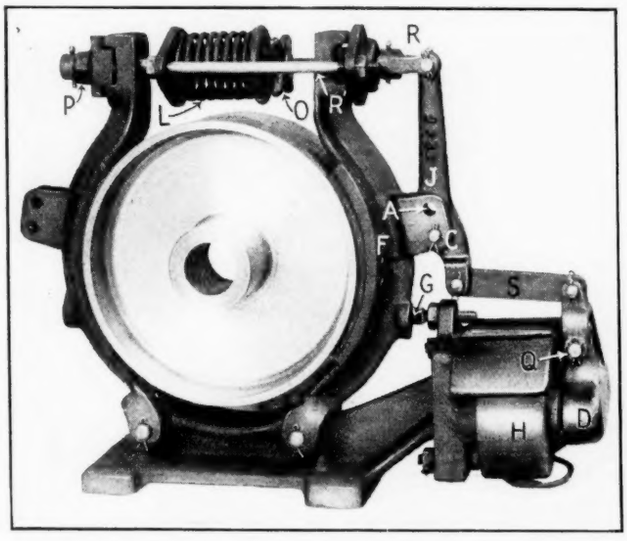


Fig. 3—Brake for use on small direct-current and alternating-current machines

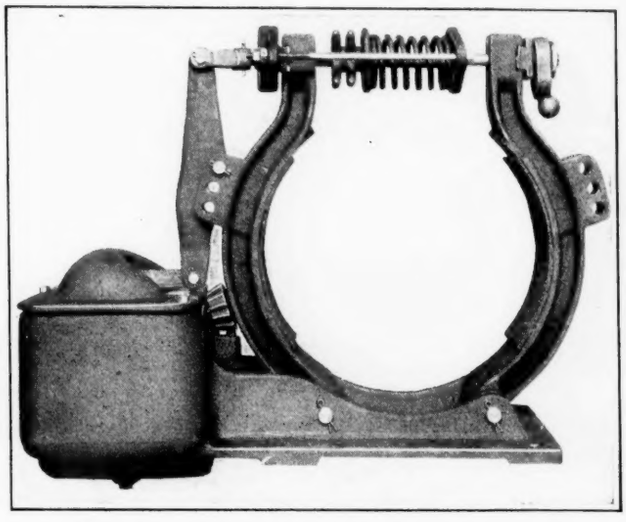


Fig. 4—Brake for use on medium-capacity alternating-current machines

Work Done by a Brake

Good evidence of the amount of work done by a brake is the temperature of the brake shoes and brake pulley. Brake-shoe linings that last many years in direct-current elevator service will last only a few months in alternating-current service.

In alternating-current elevator service, the heavy brake spring pressure required, produces an objectionable effect that is difficult to eliminate; that is, the abrupt stop so characteristic in this class of elevator service.

Alternating-current brake magnets have characteristics that are quite different from those of direct-current magnets of similar design. A direct-current magnet takes the same current regardless of the position of the armature, but the pull of the magnet increases rapidly as the air gap is reduced. An alternating-current magnet takes several times as much current when the air gap is large as it does when the magnet is closed. Most alternating-current magnet coils will develop an excessive temperature and burn out if left with the current on and the armature in the open position. The pull of an alternating-current magnet is more nearly constant throughout its stroke than in the direct-current magnet. A direct-current magnet pulls more slowly and the action is smoother and softer than the alternating-current type. The action of the alternating-current magnet is more abrupt both in closing and in release. This is one of the reasons why oil dashpots are used on alternating-current brakes.

In an alternating-current magnet, on account of the alternating magnetic field produced by the current, the magnetic circuits are made of laminated iron or steel, instead of being solid as in direct-current work. If a solid core were used for alternating-current work, the eddy current losses in it would be so high as to cause excessive heating and in other ways interfere with the satisfactory operation of the magnet. If single-phase magnets are used, a short-circuited copper loop (generally known as a shading coil) must be used in the face of the magnet core to reduce the noise when in operation. The difficulties encountered in the use of single-phase alternating-current brake magnets have caused many elevator manufacturers to use polyphase magnets. Some of these are of the plunger type, and others of the rotating type.

Brakes With Polyphase Magnets

Fig. 1 shows a cross-section through a polyphase alternating-current brake, built by The Warner Elevator Manufacturing Company. In this brake a slotted laminated core supports four coils *A*, *B*, *C* and *D*. To obtain a more even distribution of the pull over the face of the magnet the coils overlap each other. On the left-hand side of the magnet, counting from the top, coil *A* is in slots 1 and 3, while coil *B* is in slots 2 and 4. Coils *A* and *C* are connected in series and to

one phase, where coils *B* and *D* are connected in series and to another phase of the power supply. The armatures *E* are supported in loops *F*, which in turn are supported at the top and bottom, and act as guides for the movement of the armatures. Plungers *P* are also attached to loops *F* and act as pistons in the dashpots *G*. This whole structure is made up as a unit and is

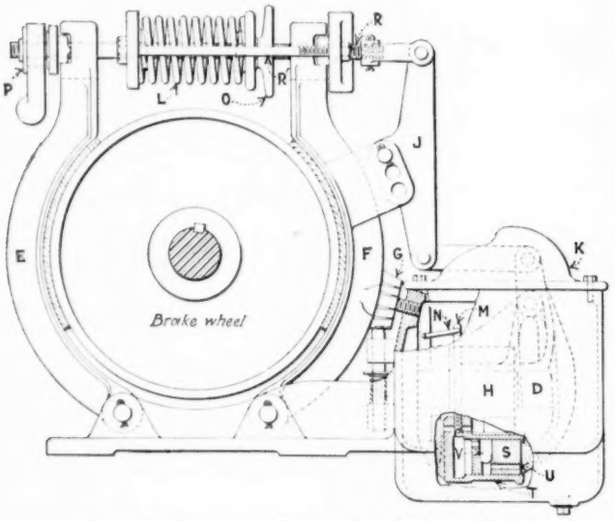


Fig. 5—Cross-section of the brake, Fig. 4

supported from the cover of the tank in which it is immersed in oil.

Connection is made between the brake levers *H* and dashpot pistons *P* by gooseneck links *N*. It might appear that the gooseneck links would result in a binding or twisting action. This, however, is not the case since the connection to the pistons on the inside of the oil pot is directly in line with the fulcrum-pin connection to the brake lever on the outside, and gives the same effect as a straight rod brought out through the side of the oil pot to the brake lever.

The brake-shoe levers are fulcrumed at *J* and the springs S, which are in compression, force the hardwood-lined brake shoes *K* onto wheel *W*. When adjusting the brake the stroke adjusting studs *R* are screwed into or out of the gooseneck links *N* until, when the magnet is closed, the shoes will just clear the brake wheel. Capscrews M are screwed in until they will just about touch the shoes. These are intended to allow the shoes free play to adjust themselves to the wheel and at the same time prevent their top ends from falling over and riding on the wheel when the brake is released. When the brake has been adjusted to obtain the proper clearance, the force with which the shoes are applied to the wheel is adjusted by changing the tension of springs *S* with adjusting studs *O*. The same amount of tension should be given to both springs and can be determined by their length, which should be the same for each.

When the coils are energized, armatures *E* are attracted to the core and move the top ends of levers *H* toward the magnet and the brake shoes away from the wheel and compresses springs *S*. De-energizing the coils releases armatures *E* and the springs push the top ends of levers *H* away from the magnet and the shoes onto the wheel. The movement of the armatures toward the magnet also moves the pistons *P* out of the dashpots and tends to create a vacuum, thus temporarily reducing the effective pull of the magnet. When the magnet is de-energized, the oil that has flowed into the dashpot is compressed and the application of the brake shoes is retarded, thus the same dashpot provides a retarding force in either direction.

Each brake is carefully tested and adjusted for rapidity of the stroke at the factory, and no attempt should be made after installation to alter the dashpot action unless abnormal conditions make this necessary. Plugs are provided in the dashpots, which can be replaced by others having suitable openings for the possible adjustment of the action in case of necessity.

It is important that the oil be maintained at the proper level in the brake-magnet housing. If the dashpots are not completely covered with oil, air will enter, causing the brake to slam, and oil will be sprayed out of the case. If oil gets on the brake shoes and wheel, the coefficient of friction will be reduced and the car will slide. The oil should be scraped off the shoes and washed off the pulley with gasoline. It should be changed about every six months, because oil sludges when subjected to heat and exposed to the atmosphere. The manufacturers use a special grade and substitutes should be avoided.

Fig. 3 shows a brake that may be used on small direct-current or alternating-current machines and shows the general principle employed in the line of brakes built by the F. S. Payne Co. The armature *D* of magnet *H* is fulcrumed at *O* and is connected to the lever *J* by the link *S*. This lever is fulcrumed to the brake shoe at *C* and the upper end connects to a threaded rod *R*. Rod *R* passes through clearance holes in the top of both brake shoes, but acts against the tension of spring *L* through a nut *O*. The left-hand end of spring *L* is attached to the top of the right-hand brake shoe by two rods, one on each side of the spring. One of these rods can be seen at *R'*. From the arrangement it can be seen that the spring acts on rod *R* to pull

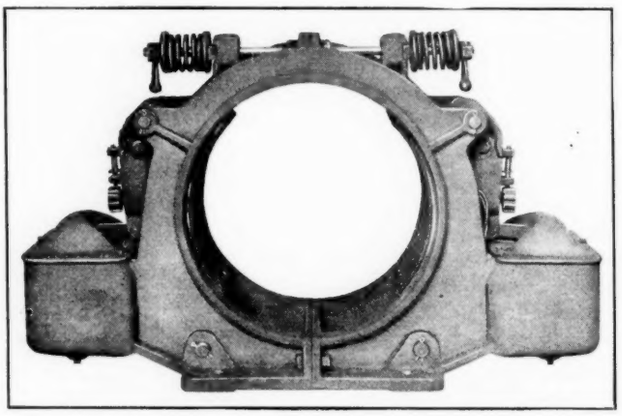


Fig. 6—Brake with two magnets for use on large-capacity machines

the left-hand brake shoe onto the wheel, while it acts on rods *R'* to pull the right-hand shoe against the wheel.

When magnet *H* is energized, it attracts its armature *D* and in doing so pulls the right-hand brake shoe against stop *G*. Further movement of the armature causes the top end of lever *J* to move toward the left, pushing rod *R* in the same direction against the tension of spring *L*. This releases the left-hand brake shoe and allows it to fall away from the wheel. When the magnet coil *H* is de-energized, armature *D* is released and the brake shoes are applied to the wheel by

the tension spring *L*, as has been previously explained.

When this brake is applied to alternating-current elevator service, a polyphase coil is used. A brake, similar to that in Fig. 3, for use on medium capacity alternating-current machines, is shown in Fig. 4. The chief difference in the two is their size; the brake Fig. 4 has its magnet immersed in oil, and the action of the

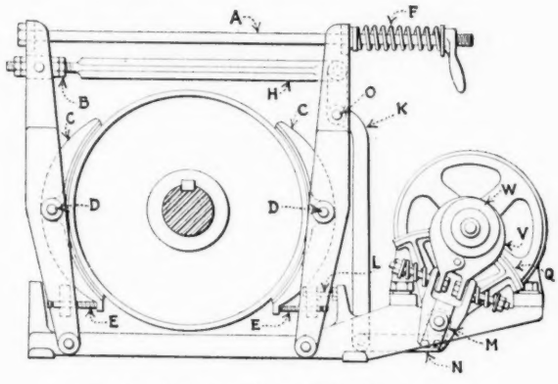


Fig. 7—Drawing of brake, Fig. 8

brake is controlled by a dashpot. The action will be made clear by an explanation of the adjustments on Fig. 5.

To adjust the brake (Figs. 4 and 5), first remove the cover *K* from the oil container. Then adjust spring *L* so that it will exert a light pressure on the brake shoes. Following this operation adjust stop *G* so that when brake shoe *F* is released and rests against this stop, it will clear the brake wheel by the smallest amount possible and yet give a running clearance. Next adjust nut *P* to a position that will allow shoe *E* to clear the pulley by the smallest running clearance when the brake is released and shoe *F* is against stop *G* by pressing armature *D* against the magnet core *H*. When trying the movement of the brake, it is necessary to apply the effort directly to armature *D*, otherwise lost motion in the mechanism may lead to wrong conclusions regarding the adjustment. Armature *D* may be moved by a small lever prying against it and over the top edge of the oil pot as a fulcrum. The most satisfactory operation of the brake will be obtained when adjusted for the smallest possible movement of the brake shoes, which will be when armature *D* has a movement of $\frac{1}{4}$ inch.

For direct-current applications, lever *J* is connected to brake shoe *F* with a pin in hole *C*, as this permits operating the magnet with a shorter air gap. For alternating current, hole *A* is used. Although the air gap in this case is somewhat increased, there still obtains practically the same pull, but with a better leverage on the shoes. This gives a somewhat stronger brake for alternating-current work, which is desirable, as the brake has to be relied on entirely for making stops, since dynamic braking cannot be used, as is possible on direct-current applications.

For alternating-current brakes put transformer oil in the oil container until the brake magnet coil is just covered. No oil is necessary in direct-current brakes. After the oil has been put into the container, adjust the dashpot vent screw *M* to a position that will give a decided retarding effect when armature *D* is moved by hand to the position where the brake is released. Vent screw *M* is adjusted by one-half turn and is locked by means of a yoke *N*. The brake coil can now be energized and then de-energized and the action of the brake observed. A readjustment of vent screw *M* will probably be necessary. Adjust this vent screw so as to get the proper retarding effect on armature *D*. This will be when the blow observed in closing the magnet is at a minimum, but care must be taken not to close vent *M* to where it will cause the brake to be late in releasing.

The brake having been adjusted for proper movement, turn up on nut *O* until the desired brake-shoe pressure is obtained. This can be checked by the way that the brake stops the car. The brake shoes are lined with an asbestos fabric interwoven with brass wire and, until they get thoroughly fitted to the wheel, may require frequent adjustment.

The dashpot consists of a cylinder *T* and a piston *S* attached to armature *D*. When the brake is applied to the wheel, piston *S* is in the position shown in the figure and oil flows through the passageway *U* in the piston, by the ball check valve *V* and into the bottom of the cylinder. When the magnet coil is energized and attracts armature *D*, it pushes piston *S* into the cylinder and forces the oil out by the check valve *M*, since the ball valve *V* prevents it from flowing back through the passage by which it entered the cylinder.

Where a brake of larger capacity is required than that shown in Figs. 4 and 5, the type illustrated in Fig. 6 is used, which is designed particularly for heavy-duty freight elevators or high-speed passenger elevators. This brake operates on the same principle as the one in Figs. 4 and 5, the only difference being that each shoe is provided with an independent releasing magnet and is virtually two brakes in one. In this type, each shoe is adjusted independently and in the way previously explained for the brake with a single coil. In adjusting the dashpots care must be exercised to have them functioning so that both shoes will release at the same time.

Brakes Operated by a Torque Motor

A rotating magnet as applied to alternating-current brakes is simply a small high-torque squirrel-cage polyphase induction motor, so designed that it can remain

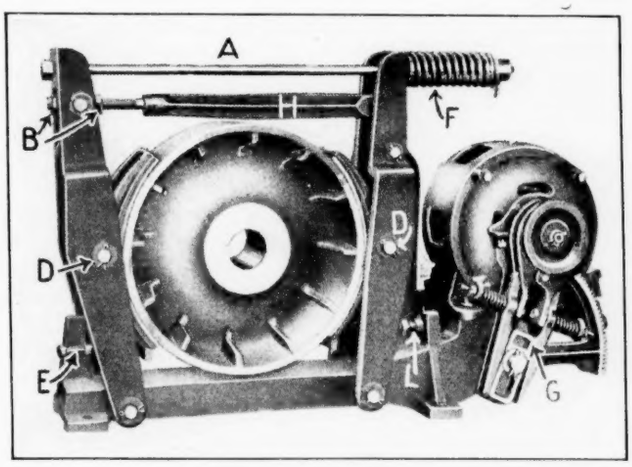


Fig. 8—Alternating-current brake released by a torque motor

stalled indefinitely. Figs. 7 and 8 show a Cutler-Hammer brake of this type. It is operated by lever *K*, which is fulcrumed in the right-hand brake-shoe support at *O*, and has its upper end attached to the left-hand brake-shoe support by the push rod *H*. The magnet's shaft is geared to quadrant *Q*, which is supported on the shaft *M*. An extension from the bottom of this quadrant is connected to the lower end of lever *K* by the

link *N*. When the magnet is energized, it rotates in a clockwise direction, which turns the quadrant in a counterclockwise direction. This motion causes link *N* to be pulled to the right and with it the lower end of lever *K* and, as previously explained, this motion of lever *K* releases the brake. At the end of its travel the magnet is stopped by an auxiliary brake *V* closing on a stop wheel *W*.

A more detailed picture of the mechanism for connecting the magnet to the brake is shown in Fig. 9. The pinion and dog *D* are rigidly fastened together and keyed to the rotating magnet. A stop wheel *W* is bushed on the shaft and is driven by dog *D*, which engages a

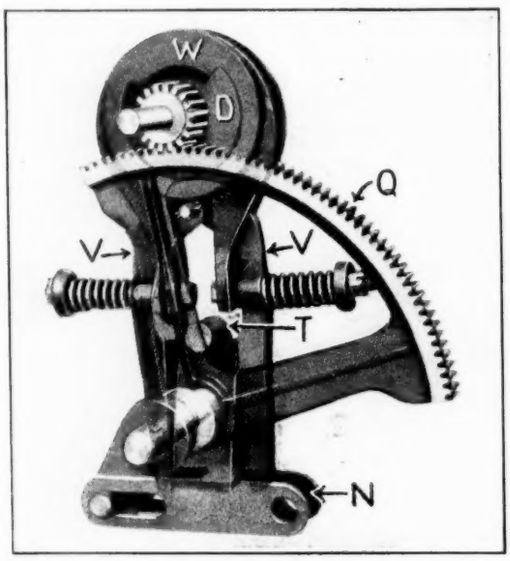


Fig. 9—Operating mechanism that connects torque motor to brake, Fig. 8

projection cast on the inside of the stop wheel. There is a one-half revolution of lost motion between the stop wheel *W* and dog *D*. When the quadrant *Q* has reached near its limit of travel in either direction, a rib on the quadrant arm engages a projection *T* Fig. 9, on the cam block shown at *G* in Fig. 8, and turns it. Turning of cam block *G* spreads the arms *V*, which applies the brake to the stop wheel *W*. The lost motion between dog wheel *D* and stop wheel *W* allows the magnet to revolve freely in the opposite direction while the auxiliary stop brake is releasing. A lost motion slot is provided in link *N* so that the main brake shoes can apply before the auxiliary brake applies. The brake should be so adjusted that when the shoes are applied to the wheel the pin will be about in the center of the slot in link *N*.

The magnet coils are wound for either two-phase or three-phase and are connected to the line in the same way as a two-phase or a three-phase motor. After the magnet has been connected, if it rotates in the wrong direction it can be reversed in the same way as an induction motor wound for the same number of phases and connected in the same way.

When the brake is being adjusted, compress spring *F* until the brake shoes apply quite tightly to the wheel, then adjust nuts *B* until the crankpin is at the center of the slot in link *N*. After these adjustments have been made, release the brake by energizing the magnet and equalize the clearance between the center of the shoes and brake pulley by screw *L*. This clearance should be about $\frac{1}{32}$ in. The clearance at the top and bottom of the shoes can be equalized by the screws *E*.

When the clearances have been properly adjusted, check the operation of the brake by starting and stopping the elevator. Spring *F* should be adjusted to give a smooth quick stop, but the spring should not be given a tension that will cause the brake to act sluggish when released.

There are many other makes and designs of alternating-current elevator brakes, but the ones herein described are representative of the general principles involved. The brake mechanisms in general are not radically different from the direct-current type, the chief difference in most cases being in the magnet's construction, the use of dashpots and the immersing of the magnets in oil.

Solar Radiation Staggers Imagination

Writing in the Aug. 27 issue of *Science*, Robert T. Aitken, of the Lick observatory, gave the following interesting data on solar energy:

"Every acre of the earth's surface which is exposed to the vertical rays of the sun is constantly receiving energy at the rate of four thousand horsepower. But as seen from the sun, the earth's disk would cover only one two-billionth part of the surface of the celestial sphere. Therefore, if we make the natural and plausible assumption that the sun is radiating light and heat with substantially equal intensity in all directions, the heat radiated into space by the sun must be two billion times that intercepted by our earth. In other words, the sun must be continuously radiating energy at the rate of approximately a million million million million horsepower. That is 1,000,000,000,000,000,000,000,000 horsepower."

"What is true of the sun most be true also of every one of the stars in our system, with due regard to individual differences in mass and in temperature, and to estimate the number of the stars at one thousand five hundred million is to be very conservative. Quite recently, I have seen the number seriously set down as ten billion. We can write the figures which represent the total energy radiated into space by all these millions of stars continuously through a thousand or ten thousand million years, but who can comprehend their significance?"

DURING 1924 THE MAXIMUM 20-min. peak load, which occurred in December, on the system of the Hydro-Electric Power Commission of Ontario, was 769,952 hp. During December, 1925, the maximum 20-min. peak was 867,443 hp. The total investment in the system is $198,998,979.73. Including the investment in distribution systems owned by municipalities, the total investment in government-owned power generating and distributing equipment in Ontario becomes $276,720,073.26.

IN DESIGNING CHIMNEYS, most authorities have specified different coefficients of friction with different materials used in chimney construction. J. G. Mingle suggests that this is illogical because, after any chimney has been in use for some time, the surface becomes soot-coated and thus the coefficient of surface friction should be independent of the material.

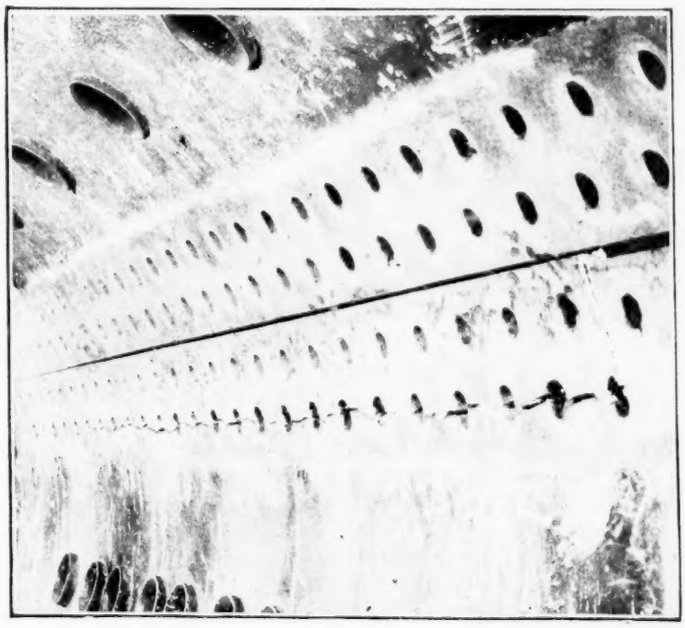
*Boiler Feed-Water Purification—X**

Embrittlement—What Causes It?

The Mystery of Boiler-Metal Embrittlement Is Gradually Being Dispelled by Scientific Investigation. This Article Sums Up the Facts Now Available and the Principal Theories Held—Information Every Well-Informed Engineer Must Have

By SHEPPARD T. POWELL
Consulting Chemical Engineer, Baltimore, Md.

INTER-CRYSTALLINE cracking of boiler steel occurring while the boilers are in service is termed embrittlement or, more frequently, "caustic embrittlement." The term is used to distinguish the phenomenon from corrosion cracking or cracks due to stresses. Failures of this nature are indicated by the occurrence of fine cracks in the metal below the water line. The general characteristics of embrittled metal may be summarized as follows: (1) The cracks occur below the water line and appear to start on the dry face of the joints; (2) the failures occur in all kinds of steel used in boiler construction; (3) the cracking is irregular, with marked changes in direction, and the cracks generally do not join one another; (4) the cracks occur usually in the highly stressed regions of riveted joints; (5) the cracks occur in the plates, the butt straps, or the rivets; (6) there is marked brittleness of the metal under shock; (7) the brittleness of the metal appears in most of the cases examined to be localized at the areas adjacent to the joints; (8) black iron oxide or sulphide is present in embrittled areas; (9) ductility may be restored to some extent by heating the metal or by removing the boiler from service for a time.



Inside of ten-year-old Stirling boiler drum, with crack through consecutive rivet holes

The number of boiler failures due to embrittlement has not been large. Failures have occurred, however, at sufficiently frequent intervals to attract marked attention of operating engineers, especially in certain sections of the country. Two theories have been advanced in order to explain the cause or causes of the trouble. These are both given herewith in order that the reader may have the benefit of such facts as have been fairly well established by investigators.

It has been claimed by some investigators that the primary cause of embrittlement is improper processing of the metal or localized stresses set up by the method of fabrication employed. It is claimed further that the concentration of caustic soda in the water used for boiler feed is not responsible for this phenomenon, since the concentration of this salt in boilers may not be carried to a point where the metal could be so affected. Opposed to this view is the theory of caustic embrittlement. The advocates of this theory contend that embrittlement is the result of the absorption of hydrogen released by the decomposition of caustic soda which may take place at high temperatures and pressures and in the absence of other salts (principally sulphates), or at least when these salts are present only in small amounts. As early as 1866 Graham[1] made the interesting discovery that red-hot iron was penetrated by hydrogen and that a portion of the hydrogen was retained by the metal after it had cooled down. Caillet[2] and Johnson[3] showed that hydrogen generated electrolytically was absorbed by iron at ordinary temperatures. Gaseous hydrogen, however, did not affect the metal at all. Johnson's experiments showed that soft iron became brittle shortly after the hydrogen generated electrolytically came into contact with it. When the wire was treated with acid, the rate at which the embrittlement proceeded was greatly accelerated.

Thompson[4] reported that solutions of soda at boiling temperature and fairly high concentrations had no appreciable effect upon the physical properties of steel wire. The same investigator found that the steel wire was much more seriously affected by boiling water.

*Previous installments have covered the following subjects: July 6, "Natural Waters and Their Impurities"; July 13, "Getting Rid of Impurities by Sedimentation and Coagulation"; July 20, "Filtration by Gravity and Pressure Filters"; July 27, Softening Water by Chemicals"; Aug. 3, "Hot Process Continuous Softeners"; Aug. 10, "Zeolites Explained"; Aug. 17, "Where Zeolites Fit in"; Aug. 24, Boiler Compounds"; Aug. 31, "Priming and Foaming."

[1]Proc. Royal Society, Vol. 17, p. 219, 1869.
[2]Compt. Rend., Vol. 80, p. 319, 1875.
[3]Proc. Roy. Soc. Vol. 23, p. 186, 1875.
[4]Journal of the Society of Chem. Industry, 1894.

Andrews[5] in 1914 stated that strips of steel kept in concentrated sodium hydroxide at 212 deg. F. for periods of from one to seven weeks were embrittled. Hydrogen was evolved as a result of the action of the caustic soda. This experimenter found that the embrittling action was more pronounced in the early stages of the experiments and that brittleness of the metal finally disappeared.

Parr Summarizes Results of Study

In 1917 Parr,[6] as a result of extensive experimentation on the embrittlement of boiler metal, summarized the results of his study as follows: The peculiar cracking or faulting of boiler plates under consideration occurred:

"a. Below the water line.

"b. In connection with leakage at seams and rivet holes.

"c. Accompanied by an exterior incrustration of strongly alkaline character.

"d. Where the water employed contained a very considerable amount of caustic soda (NaOH).

"The experiments, as a result of this general agreement in the conditions, were directed toward determining the effect of caustic soda upon steel or the indirect effect of hydrogen resulting from such action. In general, there seemed to be sufficient data for concluding that—

"a. Caustic soda of sufficient strength attacks iron with the generation of hydrogen. Indicating the reaction with the hydroxl ion only, we would have $3Fe + 4OH = Fe_3O_4 + 4H$.

"b. Hydrogen in the nascent state, whether generated by alkali or acids, enters into the texture of the iron in a way to modify its physical properties.

"c. The hydrogen effect, at least in its first application, is transient; after a period of rest or freedom from the hydrogen action, the iron reverts to its normal condition."

"d.[7] Sodium carbonate as such is without action on iron and therefore cannot generate hydrogen. Under boiler conditions sodium carbonate gradually 'hydrolizes,' that is, changes into caustic soda. The rate at which this takes place depends on temperature and other conditions such as the removal of the CO_2 produced by the change.

"e. Certain accompanying salts, as chromates, have an inhibiting effect. Other salts, as sulphates, have at least the effect of acting as diluents. The limits of concentration for maintaining a condition which would be below the danger point have not been studied, but are features of the case which are of the utmost importance."

Parr states further in the same report: "The evidence seems to show that the embrittling effect of sodium hydroxide on steel is due to the evolution of hydrogen and the absorption by the steel of the hydrogen in the nascent state. However, there are two other possibilities which may be considered:

"First, there is the possibility that the alkali actually works into the metal, eating out the 'amorphous intercrystalline cement,' which, being thermodynamically less stable than the crystals, would be first attacked. This would cause a brittleness akin to that caused by burning or overheating and fracture would be inter-crystalline.

"Second, Andrews claims that sodium hydroxide causes a 'crystallization,' by which he means a coalescence of the smaller crystals into larger ones. This effect would also be the same as that caused by overheating."

T. S. Fuller, reporting the results of experiments in a paper[8] read in 1919, showed that the rate of absorption or penetration of hydrogen through a sample of electrolyzed iron was practically the same with one per cent caustic soda as when tap water was used.

Rosenhain and Houser[9] claimed that inter-crystalline fracture (embrittlement) results primarily from strains set up during fabrication of the boilers and not from corrosive action such as might be set up by the absorbtion of hydrogen released from caustic soda.

The studies of Merica[10] in 1917 indicated that the presence of high alkalinities in water tends to reduce the resistance of steel to alternating stresses.

H. Kriegsheim, in a series of articles,[11] has submitted numerous references to American and European investigators supporting the theory that strains set up during boiler construction and poor quality of metal account for embrittlement and cracking of boiler plates in service.

N. E. L. A. Report

A discussion on this subject supporting the caustic embrittlement theory appeared in the Prime Movers Report of the National Electric Light Association, 1922. This section of the report is quoted verbatim at length because of its general interest.

"Since the location of cracking of this sort is selective with respect to the parts of the seams reached by the water of the boiler, feed-water conditions should be considered, and apparently with the following conclusions in mind:

"1. Solubility will be of prime importance for the reason that a highly soluble substance may be present in heavy concentration without depositing anything on the metal to protect it mechanically.

"2. These substances should not attack the metal in the concentration in which they usually occur in a boiler, but should attack it in the higher concentration that can build up in restricted areas like the boiler joints.

"3. Acids can be eliminated from consideration, as they attack the entire metal surface at any concentration that could occur in boiler practice.

"4. Substances of high specific conductivity would increase the corrosion effects resulting from potential differences in the boiler structure.

"5. Substances such as calcium and magnesium carbonates, calcium sulphate, etc., being incrusting salts and of low specific conductivity, may be eliminated from consideration for either reason alone.

"In connection with this subject a practical question of moment is whether the use of sodium carbonate for treating feed water is likely to lead to this trouble. Nothing in the investigation work which has been thus far done indicates danger unless the result of treatment yields a water which finally, in the boiler, has what, from the operating point of view, would be high con-

[5] D. W. Andrews, Trans. Faraday Society, p. 316, March, 1914.

[6] S. W. Parr. "The Embrittling Action of Sodium Hydroxide on Soft Steel." Bulletin No. 94, Eng. Ex. Station University of Ill. 1917. p. 55.

[7] This paragraph is not quoted verbatim. It has been paraphrased to make the idea more clear to non-chemical readers.

[8] The American Electro-Chemical Society in 1919.

[9] The Iron and Steel Institute in 1920.

[10] P. D. Merica. "The Embrittling Action of Sodium Hydroxide on Mild Steel and its Possible Relation to Steam Failures of Boiler Plate. *Chem. & Met. Eng.* 16, pp. 496-505, 1917.

[11] H. Kriegsheim. The Permutit Company, Bulletin 1921, 1924.

centration of sodium hydroxide and almost entire absence of other substances."

More recently, two important[12] contributions on this subject have appeared in Germany. Doctor Bauer, of the Metallographical Institute of Dahlen, has shown that hydrogen in contact with metal and under high pressure (up to 3,000 lb.) will not affect the strength of the metal when the contact takes place at room temperatures. Doctor Bauer has demonstrated, however, that relatively small amounts of hydrogen in contact with iron or steel at boiler temperatures is readily absorbed by the metal, materially reducing its tensile strength.

Professor Thiel's research studies have shown that 77.5 per cent of caustic soda may concentrate in the clearances between the boiler plates, resulting in reducing the tensile strength of the boiler. This action, according to Professor Thiel, is due to the absorption of hydrogen which is released from the caustic soda when the sodium unites chemically with the iron.

Summary of Williams and Homerberg

The preliminary report of an extensive study of the action of caustic soda on boiler steel by Williams and Homerberg sheds much light on the problem. Their conclusions were as follows:

"1. During the crystallization of steel the impurities, to a considerable extent, are rejected to the grain boundaries.

"2. The oxides and sulphides are two of the prime factors in caustic embrittlement.

"3. The oxides are reduced under the influence of cathodic hydrogen.

"4. The sulphides are removed owing to the action of hot caustic-soda solutions.

"5. The removal of the sulphides produces a surface condition favorable to progressive corrosion.

"6. Assuming that progressive corrosion starts with the removal of the sulphides, the corrosion will be greatly accelerated if the material is stressed.

"7. In stressed areas containing oxides, the volume increases due to the reactions with cathodic hydrogen may produce stresses which, added to those initially present, may cause cracking.

"8. It seems evident that hydrogen acts in three ways to produce embrittlement: First, there is the temporary brittleness caused by absorbed hydrogen (as in acid pickling); second, it acts to reduce oxides; third, it exerts a mechanical effect due to the change in volume at the grain boundaries. This latter volume increase might create a stress which, added to those originally present, would cause cracking."

In a later report[13] the same author, after a continued study of the subject, confirmed generally the foregoing statement.

The paper of S. W. Parr and F. G. Straub presented before the American Society of Testing Materials in June of this year, confirms largely the earlier finding[14] of Doctor Parr. These authors state:

"The results indicate that two conditions must be present simultaneously to produce the embrittlement effect: First, the stressing of the metal above the yield point; and second, the concentration of sodium hydroxide to a point which is in excess of 350 grams per liter.[15] Parallel tests omitting the sodium hydroxide show no effect. Tests upon various types of metal from the purest obtainable to those with a high percentage of impurities show that impurities do not modify the conditions.

"So far as the experiments have gone, they indicate that embrittlement could be prevented by the elimination of localized stresses, if this were practicable. The modification or control of the chemical condition of the water has been found to be effective. Data on actual plants in use, covering a period of ten years, are consistent with the information gained by studying artificially produced embrittlement in showing that no embrittlement occurs when the ratio of sodium sulphate to sodium hydroxide is kept above two. Free sodium carbonate in the water is in itself not active in producing embrittlement, but contains a potential danger in that it gradually is hydrolized into the caustic form."

In a recent paper on the subject of embrittlement, F. B. Porter[16] drew some interesting conclusions regarding the possible cause or causes of this phenomenon. Mr. Porter's statement is given herewith. "It is a difficult question to decide whether boiler water leaking into the seams evaporates and produces high concentration and starts embrittlement, or whether the embrittlement and cracking start and the leaks promptly result therefrom. If the leaky condition comes first, it probably does not make much difference what the concentration of the boiler water is, for the reason that a concentration even to the solid can rapidly occur in the seam as soon as the leak starts.

"In conclusion, it seems at the present time that the only explanation of caustic embrittlement that will account for this condition being present in some drums of some plants and absent in other drums of these same plants, and absent in all the drums of other plants, using the same waters and the same type of waters, is that embrittlement is due to overstrained or dirty steel and causticity in contact with same."

Although there is still much to be learned in reference to the embrittlement of boiler metal, sufficient information has been obtained to indicate that the action may be prevented by proper treatment of feed water and by avoiding undue stresses in fabrication. Where embrittlement is indicated, it is proposed that sulphuric acid or other sulphates should be added to maintain a specific ratio of caustic to sulphate concentration in the boiler water.

Effect of Boiler Pressure

The approximate ratio of these constituents, to be effective in preventing embrittlement, will vary with the pressure at which the boiler is operated. For steam pressures up to 150 lb. the sodium carbonate plus the sodium hydrate expressed as sodium carbonate should not exceed the sodium sulphate quantity. Operating at pressures from 150 to 250 lb., the sodium carbonate equivalent should not exceed one-half the sodium sulphate, and for pressures above 250 lb. the ratio should not exceed one-third. Calking of the seams on the inside of the boiler and leaving the outside seams uncalked is practiced to avoid embrittlement. By so doing, local concentration of soluble salts is prevented. Cold working of rivets may prove to be a factor in starting

[12]Papers read at the association of "Owners of Large Boilers" at Darmstaat, December, 1925.

[13]R. S. Williams and V. O. Homerberg. "Why Caustic Soda Makes Steel Brittle." *Chem. & Met. Eng.*, 30, pp. 589-91, 1924.

[14]Bulletin 94, University of Illinois. "The Embrittling Action of Sodium Hydroxide on Soft Steel." Jan. 1, 1917.

[15]About 350,000 parts per million, or 20,000 grains per U. S. gallon.

[16]Fort Worth Laboratories, Fort Worth, Texas. His paper was presented at the Tulsa meeting of the American Chemical Society in April, 1926.

embrittlement, owing to the production of hair cracks under some conditions.

Since the results of experimental studies and actual operating data indicate that embrittlement of boilers is at least potentially possible with some water, a number of companies have inaugurated chemical treatment in order to maintain the desired caustic-sulphate ratio.

It is conceded by all who have studied the embrittlement of boiler metal that much is still to be determined concerning the physical and chemical phenomena resulting in failures of this kind. To what extent the quality of metal has been responsible for embrittlement of boiler metal which has failed in the past is an indeterminate factor. This is especially true in those cases where the failures occurred a number of years ago and concerning which specific data are not available.

Arguments on Both Sides Summed Up

The conclusions that have been advanced in rejecting the caustic embrittlement theory may be summarized briefly as follows:

1. Fuller's work has shown that as much hydrogen penetrated steel and was occluded by it, from tap water as from a one per cent caustic soda solution.

2. Excessive riveting pressures may set up high stresses in the plates adjacent to the rivet holes and in the rivets, causing inter-crystalline cracks.

3. Caustic soda may not be held responsible for the difficulty, since the concentration at which the caustic might be a destructive agent in this respect is greatly in excess of that which could be maintained in a steam boiler without causing serious operating trouble.

4. Inter-crystalline cracks may develop in ferrous and non-ferrous metal owing to improper thermal treatment.

The following factors tend to direct attention toward the quality of water as the offending agent rather than the material of which the boiler is constructed:

1. Failures have occurred largely at certain places where the water used for boiler feed contained relatively large quantities of sodium carbonate and bicarbonate and were low in sulphate.

2. The difficulty disappeared by changing the source of the feed water and using water that did not have these characteristics, or by treating the water chemically.

3. The difficulty has not been confined to the boilers of any one manufacturer.

4. Embrittlement of metal has been produced by investigators by duplicating the conditions that, theoretically, should be favorable for producing the characteristic interfacial cracking of metal.

Much has been learned within recent years concerning the phenomenon of embrittlement of boiler steel. The numerous investigations now under way in this country and abroad should be productive of still more valuable data which should confirm or reject the conflicting theories that have been advanced to account for this action.

X-Ray Examination of Steel Castings is very valuable when the castings being inspected are small. However, a maximum penetration of four to six inches is all that is possible with present equipment. Hence a multitude of steel castings must of necessity be inspected in other ways, and in many cases this presents a real problem to the manufacturer.

Condenser-Tube Dezincification

By Charles E. Colborn

Viewed under a microscope a section of new condenser tube is seen to be composed of a large number of crystals of various shapes and appearances, closely interlocked. A section of dezincified tube similarly examined will be found to have nearly all the zinc crystals gone, the removal having left gaps in the tube structure and the remaining crystals no longer being well interlocked. Thus a condenser whose tubes may be in a precarious state may give no real warning until some unwonted strain is thrown on the metal and the tubes break or collapse.

Observations of numerous condensers, after various lengths of service, have led the writer to believe that this dezincification might be greatly retarded, or perhaps prevented, by proper cleaning of the tubes.

In one installation of three surface condensers, two of 20,000-sq.ft. area, had seen about six years service and one of 35,000-sq.ft. area, about four years. After the former had been in practically continuous service for over two years, tubes that were removed for examination were found to retain their original color and showed no corrosion signs or weakening of the metal. The tubes had been cleaned with leather washer and nail cleaners, shot through with compressed air. About this time, the rubber-plug style of cleaner was introduced and was used on all three units until recently. Examinations show that all are now badly dezincified, those in the larger unit being completely gone, although the older units are still fairly serviceable.

Muntz metal tubes were used in all three, and a uniform quality of water slightly alkaline verging at dry seasons onto acid.

In another instance two 32,000-sq.ft. units were found after three years with rubber-plug cleaning to be showing bad signs of dezincification. Close examination of a large number of tubes showed the dezincified spots occurring indiscriminately. At that time also a heavy mud film was noted on the inside walls, although its significance had not been observed.

Examination of the tubes from these condensers seems to indicate that the dezincification has been caused or started by oxygen entrapped and compressed into intimate contact with the tube metal by the mud film left as a result of improper cleaning. The action of the oxygen apparently breaks the surface skin or film, giving acid waters, etc., access to the less closely grouped crystals in the tube structure. These are less resistant and action proceeds rapidly to the point of failure.

There seems, then, two logical methods of preserving the tubes. The first is to use some type of cleaner which will completely remove the mud film before it becomes a scale, but without breaking or scratching the tube skin. Secondly, if this mud scale has been formed and hardened, some means should be used which will prevent the thickening of the film, at the same time not destroying it so as to expose the unprotected metal to further action.

In making tube examinations, it is necessary to break or tear the metal in order to observe its structure without a microscope.

As it is felt that still further data are needed in proving or disproving these theories, discussion or the experiences of others with this condition would be greatly welcomed by the author.

Smoke and Politics

OVER a year ago the City of Detroit passed an excellent smoke ordinance prepared by a capable committee of the Detroit Board of Commerce, with the able co-operation of the Associated Technical Societies of the city.

This document defines the prohibited degree of smoke, and provides for the appointment of capable officials for the enforcement of the law and, what is both more wise and more important, for the instruction of the people.

> The Chief Smoke Inspector shall, among his other duties, instruct the people of the City of Detroit with regard to ways and means whereby a violation of this ordinance may be avoided. He shall advise the people with regard to . . . fuel . . . and . . . apparatus . . . best suited to the abatement of dense smoke. . . . He shall compile for the benefit of the people . . . articles dealing with the abatement of dense smoke.

This was a splendid start, delighting all who are interested in cleaner air for our cities. Of course it was plain that success hung largely on the man selected as Chief Smoke Inspector. His task of regulation and instruction calls for sound technical knowledge, thorough practical experience and inspiring personal leadership. A big man could clean up Detroit.

But time moves on apace and nothing has been done. The City Council hesitates to authorize a salary adequate to secure a high-grade engineer. The Civil Service Commission is only now preparing its examination for applicants, and, to make matters worse, the appointment of a man to this important technical and administrative post has become a matter of politics.

Detroit is a dirty city, especially so in winter. Other cities have been worse and have become better. Detroit can do it too, but she must secure the leadership of a competent man, chosen for his ability as an engineer and as a leader of men. Politics is irrelevant. A high salary will be a trivial cost. The important thing is for Detroit to get rid of smoke and to begin now.

The Operating Engineer of the Future

WHAT will the operating engineer of the future be like? As with most questions of this sort, the answer depends upon who is asked and what he had for breakfast, but an apparently reasonable prediction may be based on the assumption that the law of survival of the fittest will continue to operate and that there will be an increasing demand for economical operation.

These premises granted, two courses of evolution are possible. If one of these prevails, the operating engineer of the future will be a man who combines the ability to keep the wheels moving with a knowledge of business and economic considerations. He will, as now, be well equipped with practical information on such subjects as lubrication, fits, balance, vibration, machine erection, packing and pipefitting and will in addition know how to determine the layout that is commercially most economical and how to operate it with the greatest net yield on the money invested.

The alternative assumes that he will fall down more or less on the second portion of these specifications. If this happens, it seems practically certain that these higher functions of economic control will pass into other hands, perhaps those of a "plant" engineer or some other technically trained executive.

Evolution along both these lines is now in progress, and it is largely up to the operating engineer himself which gains the ascendancy in the not distant future.

The Slide Rule Before the Stillson

HOW often about the plant are jobs done without planning! How often are they done with little thought in advance! Something comes up and the workmen are pushed to get things installed and running. Speed seems the important factor, yet many a job is held up for weeks while merely waiting for the word to start.

Mechanics or tradesmen doing the work are entrusted with the planning, although quite ignorant of all conditions to be met. A pipe line is run as suits the fitter's fancy, only to be torn out a month later because of further improvements. From the panel board an electric line is run to a motor. The new line parallels an old one; the old one could not carry the extra load.

An old service pump has needed replacement for a year. No thought was given to ordering a new one carefully selected to handle the work efficiently. It finally breaks and the local supply house is rushed to install whatever they have in stock. New machinery is set up with no thought of further expansion and a while later has to be moved. Would careful thought in advance be worth while?

A certain progressive concern was engaged in the manufacture and installation of air-conditioning equipment. It may seem like merely a job for steamfitters and tinsmiths to set up a few pipe coils and air ducts. But certain temperatures are to be maintained; the moisture content of the air must be controlled. Clearly, in an undertaking of this kind, guesswork will mean failure. The reputation of the firm is at stake. Careful plans and computations must precede action. It is not surprising that the organization adopted the slogan, "The Slide Rule Before the Stillson." They have found that it pays.

Evidently, not all organizations believe in this policy. Even in placing cumbersome pieces of power-plant equipment, serious errors are made. There is a fine hotel in New York City that was built not so many years ago where the boiler tubes were apparently thought to be of

an everlasting type. When new tubes are needed in these boilers, a hole will have to be cut in a concrete wall.

Out in Ohio is another hotel where a similar mistake was made. An engine, driving a 100-kw. generator, was placed with the cylinder head only a foot or so from the foundation wall. When overhauling the engine, it was necessary to cut a good-sized hole in the wall so that the piston and rod might be removed.

It seems almost unbelievable that such mistakes occur in practice. But these are the facts. Those doing the planning are reluctant to admit any limitations of their knowledge. The co-operation of the manufacturer and an experienced operator with the architect (or whoever is in charge of the layout) will largely eliminate such difficulties.

Getting the Most From the Coal Pile

NEGLECTING water power, the heating and power requirements of industry are supplied by burning fuel. In many of the industrial processes large quantities of heat are required as well as power. Where the supply of these two requirements can be combined in the same heat cycle, it will, in general, prove to be the most economical arrangement and will utilize a maximum amount of heat from the fuel burned, which should be the end sought.

One of the most common combinations is power generation with exhaust-steam heating. By this method, in cases where the power and steam demands synchronize, a kilowatt-hour can be put on the busbars for less than five-thousand heat units, which is about one-third that required in the most efficient condensing plants. In addition the heating is done as economically as when steam directly from the boilers is used. Outside of industrial plants, combination power-generating and heating processes have been little utilized. Central-station generation of power and district heating have been developed largely as independent systems, although in recent years some of the leaders in these fields are planning systems where district heating will be done by high-pressure steam taken through automatically controlled turbines on the system, which will act as power-generating units, and reducing valves to supply steam to the heating mains at the desired pressure. The low heat consumption per unit of power and the simplicity of the power-generating equipment are two factors that favor such a system.

Utilizing the heat in the gases from industrial-heating processes, offers another field of large saving in the coal pile, notwithstanding much has already been done. When speaking before the first World Power Conference, Barton R. Shover said that in the United States the waste heat available for power generation, combined with the fuel burned in the iron and steel industry for this purpose, represented five times the heat required, allowing the equivalent of two pounds of coal per kilowatt-hour.

In the cement industry up to a few years ago practically all the plants discharged the high-temperature gases from the kilns to the atmosphere, and either purchased their power or generated it by burning fuel. A modern cement plant, equipped with waste-heat boilers on the kilns, is capable of producing twice as much steam as required for power generation and heating purposes. Improvements in the utilization of heat in this industry for processes and power generation have cut the coal consumption in half. Four years ago, estimates made by an engineer of the Portland Cement Association Conservation Bureau, placed the fuel saving at two million tons a year when all the mills in the association were equipped with waste-heat boilers and other fuel-saving refinements at that time being installed.

To obtain the fullest utilization of waste heat will require close co-ordination between central stations and the large industrial plants, the former supplying power when there is not sufficient waste heat to produce all the power required in the latter, and taking power when there is an excess of waste heat, as is now being done in a few cases.

One of the arguments in favor of water-power development is the conservation of our fuel resources. This argument applies equally strong to the utilization of waste heat. A ton of coal saved by combining power generation and heating loads is just as good as one saved by water-power utilization, and should be given equal consideration when the economic factors are equally favorable.

Whys and Wherefores in Power-Plant Design

HOW easy it is to criticise the design of a plant, when one is free to say what should be otherwise with no compelling necessity of fitting the alternative design to the needs and restrictions of the actual situation.

The design of a power plant is far from a simple task, and those who criticise should remember that the engineer is often the unhappy victim of conditions not of his making or choice.

In buying a site, one must take what is available at a reasonable price. In selecting equipment, the desires of owner and operator must be considered along with the calculations of thermal performance. And sometimes during construction concessions must be made to speed, especially if there are unforeseen delays. The plant must be ready when the load needs it.

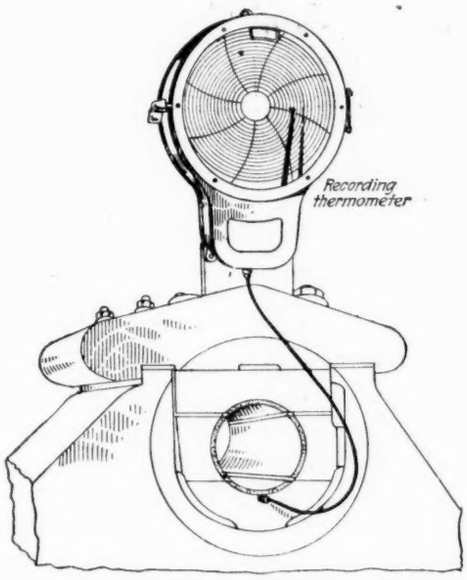
And then one should not forget that the world moves on, while the plant of today represents the decisions of two or three years ago. The greater the complexity the slower the work. Meanwhile, new ideas develop and are proved. It is rarely that a plant designer does not regret his work even before it goes into service.

To have things otherwise in a period of progress is impossible. The designer who includes all the latest untried wrinkles throughout a new plant is jeopardizing its reliability. Experiments on single units are, of course, another matter. The designer who sees nothing but thermal efficiency has to be held in check by his financial associates, for money costs money just as surely as coal and labor. One hundred dollars added to the plant investment is equivalent in cost to four or five tons of coal every year, or to a couple of man-days of labor every year. The designer is not building engineering monuments, but plants that will surely run and carry their load with the best available combination of location, efficiency, operating and maintenance expense, first cost, speed in getting under way, and a dozen other things that have little or nothing to do with engineering. In criticizing his work, don't overlook the fact that most of the restrictions are never published and can never be published. The very best job may be embodied in what appears to be quite otherwise.

Practical Ideas From Practical Men

Recording Thermometer Prevents Burning Out of Engine Bearing

Burning out of the bearings on an engine driving a large generator in an industrial plant is, to say the least, expensive, not to mention the inconvenience to the power supply. One of the difficulties in the prevention of such occurrences is, if the bearing begins to run hot, to detect it before the bearing metal is injured.



Recording thermometer installed on engine bearing

Careful attention to the bearings and their lubrication by the engineers will do much to prevent trouble, but in spite of the best efforts these bearings sometimes burn out.

To assist the operating engineers in keeping tabs on the temperatures of the main bearings of the engines, direct-reading thermometers, with electric alarms were screwed into the bearing caps. One day one of the bearings go hot so rapidly that it burned out before the temperature in the top part of the bearing became high enough to set off the alarm. After the bearing was rebabbitted a hole was bored in the metal just below the babbitt and the bulb of a recording thermometer was placed in this hole, as shown in the figure. The recorder is of the contact-making type and is connected to an electric horn, being supported from the bearing cap. The alarm circuit is energized from the generator driven by the engine. This insures the alarm being connected to a live circuit at all times when the engine is running. Placing the thermometer bulb just below the lowest part of the bearing, puts it where the temperature is the highest, and if anything goes wrong in the bearing it will be made evident at the bottom, where the greatest weight is, before it can be detected on any other part of the bearing.

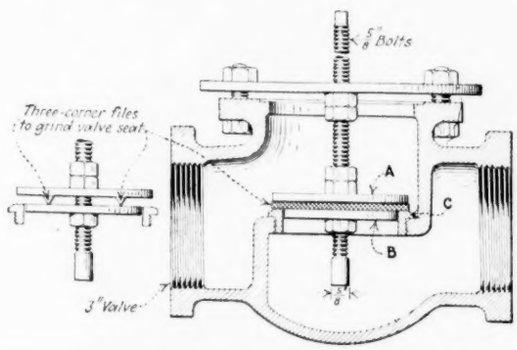
An indicating thermometer will give the temperature of the bearing at the time the engineer is looking at it, but what goes on in the meantime no one knows. If, for any reason, the bearing runs hot, there is no record left to show what happened or how quickly it happened. A recording meter gives a complete record of the temperature at all times, and a study of these records from day to day may indicate pending trouble as well as temperature changes due to a change in the quality of oil or to other causes. Since we have installed the recording thermometer on the engine bearing, it has been the means of preventing a burn-out that would have cost a number of times the price of the thermometer and alarm.

R. A. TAYLOR, Plant Engineer,
Rochester, N. Y. Taylor Instrument Companies.

Substitute Valve Reseater

Some time ago a valve on a 3-in. steam line in our plant began to leak badly, and upon taking off the bonnet I found a piece of steel about $\frac{1}{8}$ in. wide and $\frac{1}{2}$ in. long, the fine end of a pipe thread, had lodged in the disk and from repeated opening and closing had scored the seat so that it had to be reground. As we did not have a reseater, I decided to make one for this particular valve.

For the mandrel I took a $\frac{5}{8}$-in. bolt 12 in. long and extended the thread to within 3 in. of the head, then sawed off the head and ground the unthreaded portion down to fit the guide in the valve seat. For the cutting tool I decided to use two three-cornered files ground



Three-cornered files were used for cutters in the improvised reseater

to give a cutting edge. These were clamped between two $\frac{1}{4}$-in. plates *A* and *B*, as shown, the lower plate *B* being made to fit inside the seat *C*. A $\frac{3}{8}$x2-in. flat bar across the top served as a guide for the spindle, sufficient space being left between the valve body and the bar for taking up or putting the necessary pressure on the tool. The bar was squared on the end, and a tap wrench was used to turn the tool.

Chicago, Ill. OTTO QUENZEL.

Repairing End Rings on Induction Motors

To keep good connections between the end rings and bars of squirrel-cage motors, particularly some of the earlier designs, has in many cases required considerable attention. We had a number of motors that had laminated end rings pressed on the ends of the bars, that gave a lot of trouble with loose connections. The way

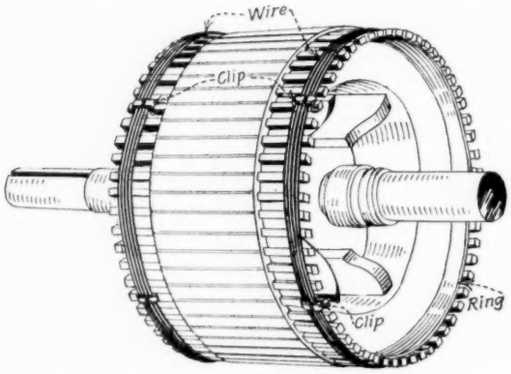


Fig. 1—Rotor with end rings in place

these were constructed made it almost impossible to get a good soldering job, so it was decided to remove the end rings entirely and replace them by one of our own design. After the ends of the bars had been thoroughly cleared and sandpapered to give a smooth surface, a flat copper ring, of a diameter that would make a snug fit, was placed inside the bars at each end. The cross-section of these rings was equal to about 75 per cent of the original rings. On the outside of the bars was wound enough No. 10 copper wire to bring the cross-section of the rings up to their original area.

In putting on the wire, the beginning end was fastened with heavy cord at the center of the core, and while two or three turns were made around the core

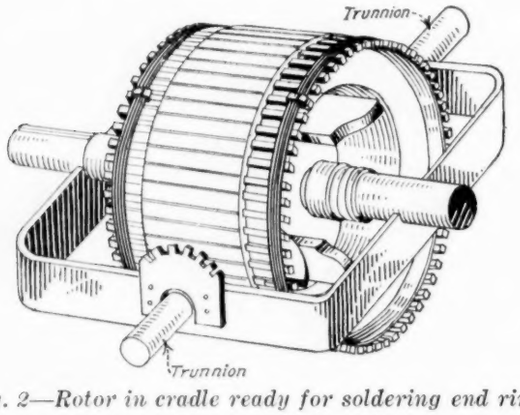


Fig. 2—Rotor in cradle ready for soldering end rings

it was worked over to the position to begin the ring. At this point a copper clip was placed under the band and three others equally spaced around the end ring, as the first turn was put on, in much the same way as the clips are put under the bands on an armature. When the required number of turns were in place, the finishing end was brought on the opposite side of the ring from the beginning and both ends soldered to the same clip, Fig. 1. After the other three clips were soldered to the band, the ends of the wire were cut free, with five or six inches of wire extending beyond the clip. These ends were bent down around the same bar to give additional security against the band wire coming loose, and also to hold the wire securely during the soldering process. When the bands had been properly secured, the end rings were thoroughly soldered to the bars by slowly turning in a pot of solder.

To do the soldering, many temporary arrangements can be devised. In this case there were a number of motors to be treated, so that considerable attention was given to making a soldering outfit to do the work. A frame, Fig. 2, was made from flat iron and two short pieces of shafting. This frame with the rotor was supported in a stand made of flat iron and angles, Fig. 3.

The soldering tray was supported in the top of an asbestos-covered sheet-iron casing, with a hole in the side for the heater, as shown in Fig. 3. An oil heater was used with the heating element extending inside the casing. After the solder had been heated to the proper temperature, the rotor in its supporting frame was put

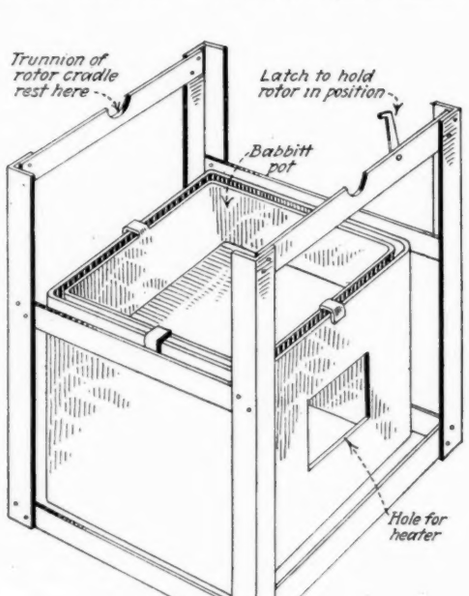


Fig. 3—Support for a rotor and babbitt pot when soldering end rings

over the solder and the rotor placed at an angle so that one side of one end ring and the ends of the bars were submerged in the solder. Before soldering, the end rings and bar ends were coated with soldering flux, and during the soldering process the rotor was turned slowly until the end ring and bars were thoroughly coated with solder. This required the rotor be turned until the end ring and bars were heated above the melting point of the solder.

To hold the rotor in position during soldering, a piece of notched sheet metal was attached to the rotor frame, as shown in Fig. 2, and a latch connected to the top of the supporting frame, as indicated in Fig. 3. When the rotor is placed in the desired position, the latch is dropped in a notch to hold it in place.

Cleveland, Ohio. H. R. SAWYER.

IN GENERAL, THE FARTHER WEST a coal is mined in this country, the younger is the coal so far as its geologic age is concerned and the higher is the proportion of volatile matter it contains.

Comments from Readers

Why Boiler Tubes Burn Out

Referring to the letter of H. D. Fisher in the June 15 issue on "Why Boiler Tubes Burn Out," I should like to state again that boiler-tube losses can be due to either internal or external causes, but in the particular case referred to in my article in the Jan. 12 issue the cause was directly traced to external influence and almost entirely due to the condensation of sulphuric acid from the oil fuel.

I notice that Mr. Fisher supports the fact that tube losses can be due entirely to external influences, as he states that perfectly clean tubes can be burned through if the heat is sufficiently intense. This is agreed.

The question of proper atomization of the oil fuel and its bearing on tube losses, as cited by Mr. Fisher, is one I am in absolute accord with.

GEORGE C. REINHARD, Chief Chemist,
New York City. Feedwaters, Inc.

Why Sixty per Cent Fail as Engineers

I have read with interest the articles appearing in *Power* as to why so few of the graduates of prominent universities and engineering schools are successful after graduation.

A great many years have been spent in honest effort by many practical engineers before they have even begun to realize their ambition to be successful. Not the majority, but the average college graduate has the idea that he is so far above the common duties of an engineer that he must at least obtain a position as chief engineer to be able to mingle with the class of men he associated with in college. When it comes to a leaky tube in a boiler that has to be cut out and changed in a hurry, few college graduates know whether the tube is welded into the drum or rolled in with a sledge hammer. I have known many, and have had a number of students work on repair work, and very few ever get to the point where they can be trusted to do a job that the employer expects his most inefficient practical man to be able to do.

In this day of high steam pressures and superheat and high-speed turbines, the part an engineer plays in an organization is fast passing from the old "monkey wrench" engineer, to the cool, clean, decisive and just executive. Many of the old timers have seen the approaching changes and are preparing themselves for good positions where merit and not "pull" counts.

Recently, a new graduate applied for a license and boasted a good deal about how simple engineers' examinations were. Here are some of the questions and his answers:

How do you find the horsepower of an engine? A. Draw your plan, then divide it by 33,000.

Another question: What is meant by a riding cutoff? A. One that rides on the mainshaft of the engine.

Just one more: Explain the action of an injector on a boiler? A. The steam goes through the injector, picks up some water; pushes it into the boiler, and mixes it with the steam to make more steam.

This is by no means a sample of all the 60 per cent that fail, but the average college graduate today, in engineering work, thinks he ought to be a consulting engineer when he graduates. Until he gets that notion out of his head and realizes that nearly all the best things in engineering are the result of years of living with the job, of study and constant companionship with the profession he has chosen as his life's work, and which is and always will be a real he-man's job—not until then will he succeed. CARL L. WILDEY.

Chicago, Ill.

Are Welded Pressure Vessels Safe?

In his article in the June 8 issue on the subject "Are Welded Pressure Vessels Safe?" E. E. Thum says that nearly all of those who criticize welded pressure vessels discuss but one phase of the problem and that is the personal skill of the welder. He says: "Unquestionably, the precautions that insure safety in a riveted vessel will do the same for a welded vessel."

With this latter statement I cannot agree. Give me any unskilled workman and two plates made ready for riveting, and have this unskilled workman put the plates together by means of riveting.

Then have the same unskilled workman weld similar plates together, in both instances being as careful and taking all the precautions possible. My prediction is that the riveted joint will more closely approach a perfect job than will the welded one. Therefore, I believe I am right in my contention that the personal skill of the welder is the most important thing to watch.

Investigations of pressure-vessel failures disclose the lack of uniformity of welds and fully support the position taken by the Bureau of Locomotive Inspection that the fusion process has not reached a stage of development where it can be depended upon in boiler construction and repair. The following is from the January, 1926, issue of the *Railway Mechanical Engineer:*

> The fourteenth annual report of the chief inspector of the Bureau of Locomotive Inspection to the Interstate Commerce Commission for the year ending June 30, 1925, again emphasizes the fact that the autogenous welding of parts of the locomotive or tender, where through the failure of such parts there is a possibility of accident and injury to persons, had not yet reached the stage of its development where it could be used with safety. In the thirteenth annual report an abstract of which was published in the January, 1926, issue of the *Railway Mechanical Engineer*, attention was directed to accidents investigated where welds made by autogenous process were involved. It was stated in that report that approximately 78 per cent of autogenously welded seams involved in firebox failures were torn, while only 15.4 per cent of riveted seams involved had failed.

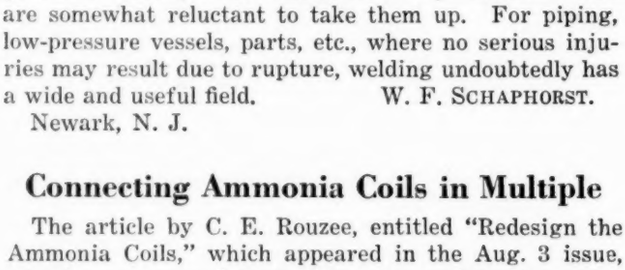
What Mr. Thum says in the remainder of his article concerning materials, design, methods of welding, testing, supervising, etc., sounds logical. I have no doubt

that if the welder's ability to make welds is carefully tested and if there can be no question about the welder's reliability, welding is all right for pressure vessels. However, after the experiences I have had with welded pressure vessels, I can understand why cautious users are somewhat reluctant to take them up. For piping, low-pressure vessels, parts, etc., where no serious injuries may result due to rupture, welding undoubtedly has a wide and useful field. W. F. SCHAPHORST.

Newark, N. J.

Connecting Ammonia Coils in Multiple

The article by C. E. Rouzee, entitled "Redesign the Ammonia Coils," which appeared in the Aug. 3 issue, contains some good suggestions for making the evaporating surfaces of brine tanks and ice tanks more effective. However, the advantages claimed for his design of piping, that of having ample gas-liberating surfaces, are possible with the shell-and-tube brine



Approved method of connecting evaporator coils

cooler when such coolers are properly designed for a given capacity output.

For example, where such coolers are provided with plenty of tube-cooling surface, 45 to 50 sq.ft. of surface per ton ice-making capacity with a difference in brine temperature between the inlet and outlet of this type of cooler limited to one deg. F., there will be sufficient volume in the brine cooler to insure proper separation of gas and liquid during evaporation.

On the larger tanks two or more coolers should be used.

As a means of protection to the compressor a liquid trap should be installed on the main suction line between the cooler outlet and the compressor, with the drain piped back to the cooler shell.

The same advantages as claimed by Mr. Rouzee for his piping may also be obtained by the use of radiator sections, which are now manufactured for application and refrigerating plants. These special sections have all the advantages possible with the piping design under discussion, and at the same time are simpler in design and cost less.

I am unable to agree with the statement that liquid accumulators should be eliminated; all the leading ice machinery builders have been supplying accumulators that have adequately met all ordinary conditions of service, including a "high ignorance factor" in certain operators.

The sketch shows two methods often used in long freezing tanks to overcome in part the disadvantages of long evaporating coils.

The liquid ammonia is fed into the coils at the bottom, and the suction is taken off at the top. A common liquid header connects all the coils together at the bottom, while the tops of the coils are connected to a common gas header, which is of course provided with a suction outlet to the compressor. C. T. BAKER.

Atlanta, Ga.

Hydrogen Generation in Steam Boilers

The editorial in the July 13 issue, on the subject of "Hydrogen Generation in Steam Boilers," called to mind the surprise I experienced some time ago when I held a lighted match in front of the air relief valve on the highest radiator of a coal-fired hot-water heating plant. A jet of blue flame several inches long issued from the outlet. This could have been nothing else but hydrogen, and my explanation is that it was produced electrolytically.

We all know that two different metals in an electrolyte produce hydrogen and one metal goes into solution. In all probability the difference in the quality of metal in the boiler itself and the piping was enough to make a weak battery, and as one metal was corroded a small quantity of hydrogen was produced.

This might be the case in a steam boiler, the metal of the headers and of the tubes being the two poles, in the solution of more or less pure water. In the case of the electric boiler the electrode, probably carbon, would be one element and the iron the other. Since carbon is at one end of the electrochemical scale, we would expect a greater voltage and evolution of hydrogen. Heat usually accelerates chemical action and possibly has no other effect. ELMER S. SMAIL.

Oak Park, Ill.

The editorial on "Hydrogen Generation in Steam Boilers," in the July 13 issue, recalls to mind a phenomenon observed while making oxygen tests of the steam and condensate system in a large central station to determine the cause of superheater corrosion.

After about a thousand tests of condensate had been taken from all parts of the system, all of which showed some dissolved oxygen, it was thought desirable to condense samples of steam to determine whether oxygen was contained therein.

All the boilers were interconnected with a small auxiliary saturated-steam heater. A gage line from this saturated header was used for convenience in sampling, the gage being replaced by a small portable condenser.

Condensation was accomplished at full header pressure by throttling the discharge. The sample was withdrawn at a temperature well below 212 deg. F. to prevent flashing, with consequent loss of any dissolved gases. The collected sample was milky white with minute entrained gas bubbles, and it was at first supposed to be saturated with oxygen. The Winkler test, however, proved it to be oxygen free. The next supposition was that free nitrogen alone was present.

A sample of gas was then collected by the downward displacement of water from a sampling bottle inverted in a water seal. The gas was so plentiful that an 8-oz. bottle full was collected in a few minutes. A lighted torch was then inserted in the bottle with the expectation that the flame would be extinguished immediately by inert nitrogen. On the contrary, instead of the torch being extinguished, there was a slight explosion, proving the sample to be a combustible gas instead of nitrogen.

A second sample was collected in a bottle equipped

with a two-hole stopper. The gas was then allowed to escape through one opening by slowly displacing it with water. Upon ignition, the sample continued to burn with a steady flame until it was completely consumed.

Samples taken from other points along the saturated line showed no dissolved or entrained gas, the phenomenon being characteristic of the one sampling point. This led to the belief that the gas formation was in some way related to the particular sampling line used. This line was examined and found to contain a length of galvanized pipe. When this galvanized section was replaced with a length of black iron pipe, the gas formation disappeared, only to reappear when the galvanized line was re-installed.

It was concluded that the saturated steam at 412 deg. F. passing through the galvanized pipe, caused a reaction between the steam and the zinc, dissociating the water into hydrogen and oxygen, the hydrogen appearing in its free state and the oxygen combining with the zinc to form zinc oxide.

This experiment apparently indicates that the placing of zinc in boiler drums to prevent corrosion is unsatisfactory, first, because the formation of large quantities of hydrogen may cause embrittlement of the steel, and secondly, because the zinc would be rapidly consumed even with boiler-feed water free of dissolved oxygen.

No further experiments were conducted to determine the boiler pressure or saturated temperature necessary to produce the reaction or to test the ability of pure zinc to liberate the gas. HERBERT M. SHARP.

Terre Haute, Ind.

Return Trap vs. Steam Pump for Boiler Feeding

Some months ago an article appeared, by Andrew F. Sheehan, on "Return Trap vs. Steam Pump for Boiler Feeding. It would appear from this article that Mr. Sheehan has never had any actual experience with the return trap system or, if so, it must have been improperly laid out. Inasmuch as he based his calculations on assumed conditions, I should like to add a few comments to those already made on this subject and give a few figures gathered from actual tests.

Some time ago I installed a steam drainage system in one of the efficient pulp mills of this country and for purposes of a test one-eighth of the drainage system on three paper machines was operated discharging to boiler-feed traps. This meant that the part of the equipment from which the condensate was fed to the boilers was not worked to capacity; therefore, the temperature of the return to the boilers was a little lower than during full operation. It was found during this test that the temperature of the condensate did not vary over 8 deg. from the time it left the paper machine until it was discharged into the boilers. The lifting traps on this job were vented to the atmosphere. Upon another date the temperature at midnight of the exhaust steam feeding the drier on one of the largest machines was 228 deg., and at the same time the temperature of the condensate that the return traps fed to the boilers was 225 deg., the boiler pressure being 125 lb. gage. At three o'clock in the afternoon, owing no doubt to a heavier weight of paper going through the machine, they brought the steam temperature going into the drier up to 280 deg., and at this time the return traps fed this condensate into the boilers at about 260 deg. Now according to Mr. Sheehan's figures, with the same steam pressure being used on the traps, the temperature of the condensate going into the boilers would be the same at the two periods mentioned. As a matter of fact, upon comparing the temperature chart on the condensate return and the steam-pressure chart on the header feeding the drier, it will be found that as the initial temperature of the steam goes up on this header, the temperature curve of the return condensate follows it. The boiler-feed traps in this case vented into an open-type feed-water heater in which the pressure was about 1 lb. gage, whereas the lifting traps vented to atmosphere.

In another department of this plant which is supplied by another boiler room, I installed a return-trap drainage system on preheaters and the first effect of a quadruple-effect evaporator handling 11,300 lb. of condensate per hour during normal operation. Previous to the installation of this system and in accord with the evaporator builders' instructions, this condensate was returned directly to the open-type feed-water heater by gravity. After the system was installed, the evaporation per pound of coal went up 0.8 lb. As the condensate that this system returned to the boilers amounted to about 31 per cent of the total evaporation, the system showed a material fuel saving.

If Mr. Sheehan had investigated conditions in various plants, he would have found that in some cases, on a drier for instance, at some lower pressure, a return-trap system would be returning the condensation to the boilers at a temperature of, say, 240 deg., whereas in another plant with a higher steam pressure on the drier but the return trap being operated at the same boiler pressure as the first one, he would find the condensate being returned at a temperature of, say, 340 deg. Why this difference if the same temperature of steam is used to operate both these traps? It is quite possible to get this temperature, even though both of these traps may have a vent to atmosphere.

I have in front of me charts from one plant in which the total evaporation of two 2,500-sq.ft. vertical water-tube boilers is fed from an open-type heater, by return traps. The chart shows the temperature of the feed water coming from the heater at 205 deg., and the temperature as discharged by the boiler-feed traps 240 deg. The boiler pressure is 140 lb. gage. The steam used by these traps comes in contact with the water twice. I also have a chart from another plant where a single trap system returns condensation from equipment having boiler pressure on it at a temperature between 330 and 340 deg. This trap is operated by boiler pressure, which is 125 lb. gage, this being a saturated steam plant also. Thus you will see that with a lower boiler pressure and with the trap steam coming in contact with the return condensate but once, still the temperature of the water is much higher than the aforementioned boiler-feed installation where the boiler pressure is higher and the trap steam comes in contact with the water twice.

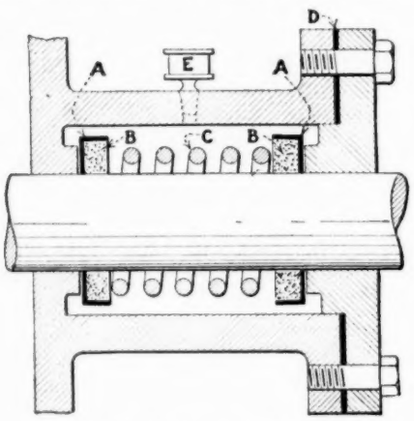
I can only reiterate the statement made by Mr. Gammon in the March 16 issue that each plant is an individual problem in itself. Also that there is a vast difference in return-trap steam-drainage systems. I might also add that even if Mr. Sheehan may not have had the proposition presented to him properly, still such theoretical conclusions as he has drawn make it hard lots of times for the salesmen with something worth while to put it across. J. H. WHITAKER.

Ephrata, Pa.

New and Improved Equipment

Cooke Seal Ring for Rotating Shafts

While developing a domestic refrigerating unit, George J. Cooke, 30 North Green St., Chicago, saw the necessity of a foolproof seal for the crankshaft of the ammonia compressor of this unit, which projected through the crankcase to carry the driving pulley on its outer



Double seal ring for crankshaft

end. After trying a great many combinations of packings and commercial rings, he finally hit upon the idea of rotating the seal with the shaft. This plan of preventing leakage around a rotating shaft proved so successful that it has been adapted for all types of centrifugal or rotary pressure or vacuum pumps handling ammonia and other refrigerants, brine, gasoline, water and other liquids. The entire assembly, shown in the illustration, is slipped over the end of the shaft and fitted into the stuffing box, as indicated.

This particular style uses double seal rings, one at either end of the stuffing box, with a spring between to exert the pressure necessary to effect the seal. Essentially, the packing consists of a patented metal, heat-treated seal ring *A* with a housing into which is fitted any soft packing *B* such as a rubber ring, wicking or other material. A pressure of about 20 lb. exerted by the spring *C* compresses this packing against the shaft. As this packing and ring rotate with the shaft, the usual wear and tear is eliminated and the seal will last indefinitely. The only frictional surfaces are between the seal ring at either end and narrow bosses of cast iron on the gland and at the bottom of the stuffing box. The bosses are desirable but not necessary. If the gland is of brass or soft metal, it is bushed with cast iron, allowing for the boss previously mentioned. There is clearance all the way around between the shaft and the gland. To seal the joint between the gland and the stuffing box, the $\frac{1}{16}$-in. gasket *D* is used.

To lubricate the ground joints between the rings and the bosses, the stuffing box is used as an oil reservoir, the supply coming from the oil or grease cup *E*. One filling of the available space with lubricant is said to meet the requirements for months. The oil line should be maintained at least to the bottom of the shaft, so that part of the seal ring always will be submerged and the ground joint have the proper oil seal.

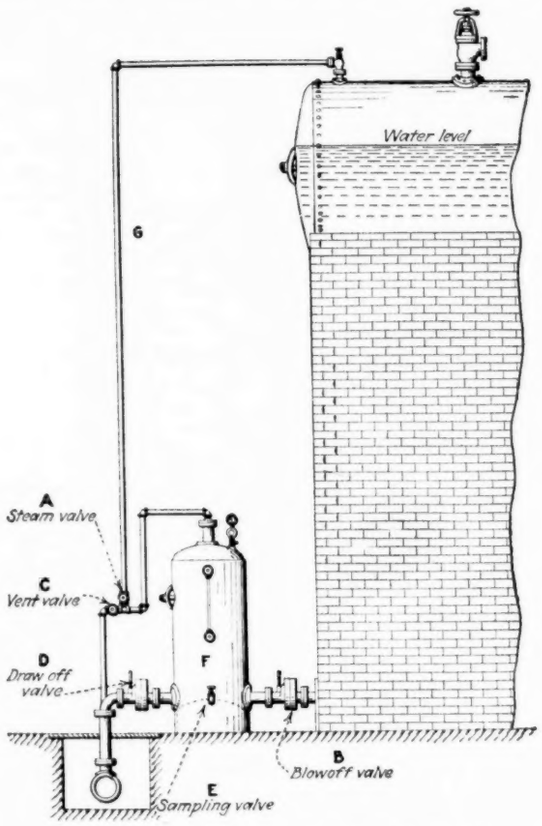
In cases where the stuffing box receives oil from splash in the crankcase, a lantern ring is used at the inner end to give access for the necessary supply.

Wylie-Wilson Process of Boiler Drawoff

With a view to promoting greater safety in the process of blowing off a boiler and decreasing the wear and tear on the blow-down equipment, a boiler drawoff arrangement known as the Wylie-Wilson Process has been brought out recently by the Everlasting Valve Co., Jersey City, N. J.

Referring to the illustration, a closed tank suitable for full boiler pressure is interposed between the boiler blowoff valve and the discharge valve to the sewer. The water withdrawn from the boiler passes into the tank and when a predetermined amount has been drawn off, the discharge from the boiler automatically ceases. The water is then withdrawn from the tank at a greatly reduced pressure.

The illustration shows a typical installation. In operation, or the process of blowing off the boiler, the steam valve *A* is opened and the tank put under boiler pressure. The blowoff valve *B* is then opened under balanced pressure and the tank *F* allowed to fill with water from the boiler. When the tank has filled, the steam valve *A* and blowoff valve *B* are again closed and the vent valve *C* and drawoff valve *D* are opened and the water allowed to run to discharge. As the water flows from the boiler to the tank under gravity head pressure and automatically comes to rest when it reaches a point in the steam pipe *G* level with the water in the boiler, the possibility of shock is avoided.



Typical installation of boiler drawoff

With this arrangement of blowoff it is possible not only to predetermine the speed at which the water is blown off, but to find out which speed gives the best results and how much water it is

necessary to blow down each time to keep the concentration at the proper point. Samples of the water are also readily obtainable from the tank for observation or analysis as the water is withdrawn from the tank at atmospheric pressure.

The system is adaptable to practically any type or arrangement of surface or bottom blowoff and to any arrangements of boilers at practically any working pressure.

Columbia Variable-Speed Transmission

A type of variable-speed transmission unit, which permits of minute adjustments of speed over a wide range, has been brought out recently by the Columbia Vari-Speed Co., 4020 West Lake St., Chicago, Ill. Fig. 1 shows a general view of the unit, while the

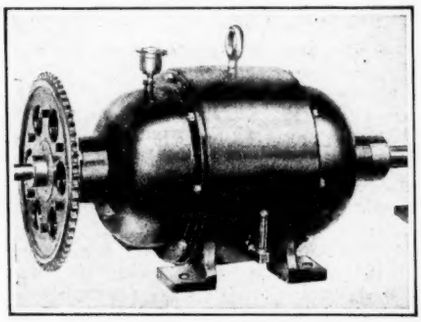


Fig. 1—Columbia variable-speed unit

section Fig. 2 shows the constructional features.

Power is transmitted in the unit by means of the traction between the hard metal surfaces of the rollers and races bearing against each other under high pressures. There are three rollers, *A*, which instead of being cylindrical, are tapered from the center toward each end, the profiles of the tapered sections being circular arcs. When the machine is in operation, the rollers move in planetary fashion about its axis, rolling around the inside of the two outer races *B* and *C* and around the outside of the two inner races *D*. The two outer races are secured against rotation, while the inner races are rotated by the input or constant-speed shaft *S*. Each roller is mounted in a yoke *G* and the yokes are carried on each of the three projecting shafts of spider *M*. The spider is therefore pulled around after the rollers as they move through their circular path between the races, and the output or variable shaft *R*, to which the spider is keyed, is thus rotated. The rollers will necessarily turn shaft *R* at a slower speed than that of the inner races, but the ratio of the speed of the inner races to that of the rollers depends on where the points of contact occur between the rollers and races. Thus, in order to vary the ratio of speeds between the input and output shafts, provision is made for shifting these points of contact. The manner in which the points of contact move in relation to each other is illustrated by the diagrams shown at the left of the sectional view.

In order to change the relative positions of the parts, the outer race *C* is mounted in a sliding frame *J*. It is made to move along the axis of the machine by turning the control wheel *O*. As the space between the outer races widens, the rollers are forced outward by the springs *E* which also cause the traction between the rollers and races.

The shaft *H*, on which are mounted the inner races together with the springs, forms a floating unit which is flexibly connected to the shaft *S* by the pins *I*. The ball thrust bearing *L* is placed behind the flange of sleeve *K* to facilitate turning the control wheel.

Lubrication is effected by partly filling the casing with oil. The oil is thrown outward by the revolving rollers and is led to all working parts through a system of passages.

To meet the requirements of practice, a range such that the maximum speed is about equal to five times the minimum has been found sufficient, and standard units are designed to have this range. Any speed between these limits can be obtained by simply turning the control wheel. In cases where large reductions of speed are desired, gears are included within the housing.

Advantages claimed for this type of unit in addition to high efficiency are ready adjustment of speeds over a wide range, noiseless and vibrationless running at high speed, and small space required per unit of power delivered, a three-horsepower unit requiring less than a cubic foot of space.

The P & B Oil Burner

An oil burner of the steam-atomizing type in which the jets of steam and oil are brought together at an angle of 90 deg., tending to atomize completely the oil inside the burner, has been brought out recently by F. Beers Co., Newark, N. J.

The burner consists of three parts—the cap *A*, the body connecting piece *B* and the central plug *C*. The cap *A*

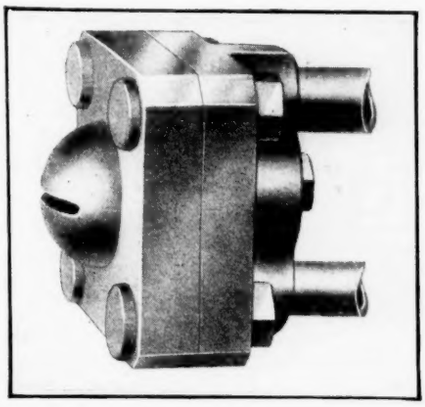


Fig. 1—Burner assembly

contains a circular chamber which distributes the steam to four jets spaced equidistant. The oil is distributed to the jets surrounding the plug *C* by means of the recess in the body *B*.

No adjustment of the burner when in operation is necessary, the correct size of the oil and steam ports being determined by the pressure available and the capacity required. The burners

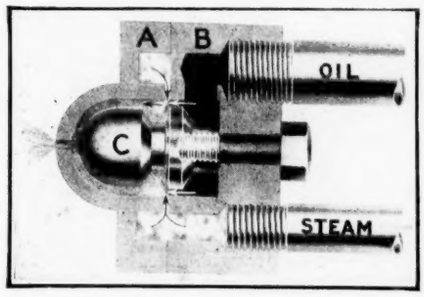


Fig. 2—Sectional view of burner

can be altered when desired, for both larger and smaller capacity, by changing the size of the oil and steam ports along with the tip opening. One of the claims made for this burner by the manufacturer is the small amount of steam required for atomization, the consumption being given as 1.3 per cent of the steam generated.

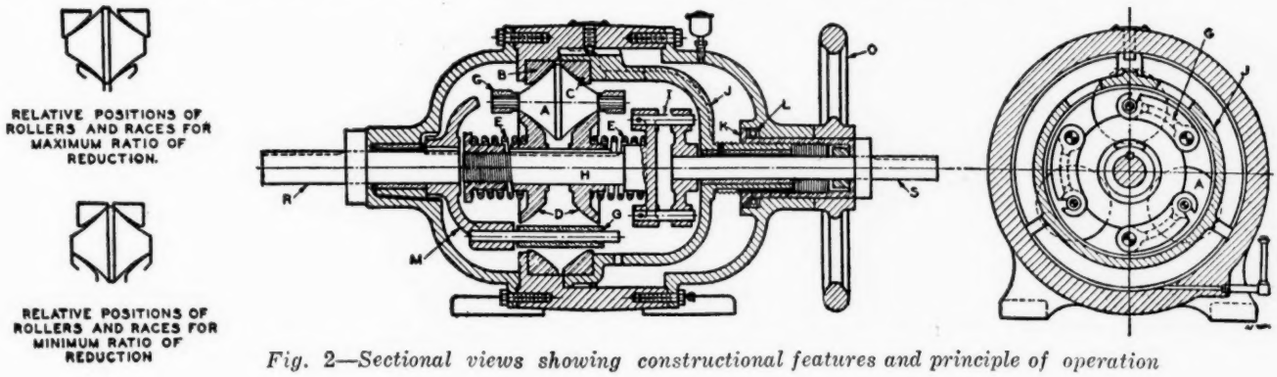

RELATIVE POSITIONS OF ROLLERS AND RACES FOR MAXIMUM RATIO OF REDUCTION.
RELATIVE POSITIONS OF ROLLERS AND RACES FOR MINIMUM RATIO OF REDUCTION

Fig. 2—Sectional views showing constructional features and principle of operation

News in the Field of Power

Brooklyn Edison Operating Largest Steam Turbine

For the first time the Brooklyn Edison Co. put into operation on Sept. 1 the largest steam-driven electric generating unit ever built.

This generator, costing over $1,000,000, is the fourth machine to be installed in the company's $50,000,000 power plant at the foot of Hudson Avenue, Brooklyn, N. Y. Built by the Westinghouse Electric & Manufacturing Co., it delivers 80,000 kw. at 90 per cent power factor, which is equivalent to developing about 125,000 hp. The overall length of this machine is 64 ft. 6 in., and the entire unit weighs more than 2,000,000 lb.

In addition to the turbine and electrical generators this equipment also includes an 80,000-sq.ft. Westinghouse surface condenser of the two-pass radial-flow design, similar to the 70,000-sq.ft. condensers on the 50,000-kw. turbines, which have been in operation for a year or more. The new surface condenser is also the largest of its kind ever built.

Fed by East River

Some conception of the size of this condenser can be obtained from the fact that 144,000,000 gal. of water, taken from the East River, are passed through it by two circulating pumps every 24 hours, when the unit is carrying full load. This, together with the other three units, will pass a total of 576,000,000 gal. per day, which is more than the combined daily water consumption of both the boroughs of Manhattan and the Bronx.

Speaking of this new generator, Matthew S. Sloan, president of the Brooklyn Edison Co., said in part.

"An electric utility must keep in mind the best possible service for the community the utility serves. To keep pace with the rapid growth of Brooklyn and the constant increase in demand for electric power and light during the 39 years of its existence, the Brooklyn Edison Co. has continually increased its capacity by building new generating and distributing stations and by installing larger and more efficient generating units in stations already in operation.

Cost 5 Per Cent of 1880

"It is interesting to know," asserted Mr. Sloan, "that light is the only commodity which has steadily decreased in price during the last 40 years, a period characterized for the most part by rising prices. Light at present costs only 5 per cent of what it did in 1880. It is now and will continue to be the policy of the Brooklyn Edison Co. to share voluntarily with its customers every benefit that accrues to it and every saving it can accomplish by more efficient methods and a devoted spirit of service that made the rate cut possible.

"The central point of focus of the plans for development was the new Hudson Avenue Generating Station and an essential feature of the plans, both for the generating and distributing systems, was that all new installations should be of such a character that they would be permanent regardless of the growth of the system.

"Every attempt was made to have this massive group of buildings of the Brooklyn Edison Co.'s plant an architectural addition to Brooklyn's water front. The enormous size of the building did not admit of embellishment in the way of mere prettiness, and so the attempt was made to carry out the masses of the building in such a way as to give the effect of great strength on the one hand, and of clean fine workmanship on the other."

Welding Exhibit to Be Held At Annual Society Meeting

Held jointly with the eighth annual fall meeting of the American Welding Society to assemble at Buffalo, N. Y., Nov. 16-19, this year's International Welding and Cutting Exposition will have on exhibit new developments in welding apparatus and supplies. A unique feature of the exposition will be the display of a large variety of welded products. The exposition will open Nov. 15.

Technical sessions include authoritative papers and discussions on "The Design and Development of Welding Apparatus"; "Organization of Welding on the Railroads"; "Welding of Locomotive Parts"; "Welding Science in the Engineering Curriculum of Universities"; and "Arc Welding in a Gaseous Atmosphere."

On Friday afternoon, Nov. 19, an inspection trip will be made to Niagara Falls. Members of the society and their guests will view the Falls from the American side with a short inspection trip through the Niagara Falls power house. This will be followed by a buffet supper on the Canadian side, and then a special illumination of the Falls will be shown, returning to Buffalo late in the evening.

A dinner dance will be held the evening of the 16th at the Hotel Statler. Special arrangements have been made as to entertainment features. In addition, arrangements have been made for a dinner.

A meeting of the American Bureau of Welding and of the Welding Wire Specifications Subcommittee will be held the afternoon of Nov. 16. The remarkable progress made by the research department of the American Welding Society (American Bureau of Welding) will be a source of satisfaction to the members of the society and the welding fraternity.

Young Hits State Ownership —Favors Canadian Plan

Owen D. Young, chairman of the board of the General Electric Co., before leaving Albany, N. Y., Aug. 24 indicated his disapproval of the policy advocated in New York State to make electrical developments pay for themselves in fifty years and then become state property. This, in his opinion, is a mistake because it would cause power rates to be higher, when it might be just as well to make them lower, not only to attract industries but to enable them to meet competition.

"This is not a question of the power companies being unwilling to pay the license charges," said Mr. Young, "and in any event earnings would be the same."

Mr. Young believes the suggestion made in Canada for reversing part of the Hudson Bay watershed so that the levels of the Great Lakes will be raised deserves serious attention. He understands the cost would not be as great as might be supposed, and in this way far greater power values would be derived, he said. He pointed out the matter would have to be arranged in a way so that Canada would not feel she was creating a power reservoir purely for the benefit of the United States. At the same time, Mr. Young believes it will be impossible to shut down on all the water which Chicago now takes for sanitary purposes.

The boundary water disputes between the United States and Canada, in Mr. Young's opinion, are in the way of solution, as progress in that direction is being made all the time.

Falls Solution Sure

Mr. Young would not predict when these developments might be looked for, but said that in matters of this kind it is the general practice to move slowly for a long while, and then, suddenly, a great demand appears and they are accomplished. He looks for something like this to happen in connection with the boundary waterway questions so closely allied with power development in the United States and Canada.

Mr. Young said there is a growing demand for power in New York State and a similar demand in Ontario, although some of this is going to be accounted for by new hydro arrangements. He said that power in New York, when all cost factors are considered, is sold as cheaply as in Canada.

Solution of the Niagara Falls power question is part of the Chicago diversion, Mr. Young said, so it may be some time before an agreement is reached there; but it is bound to come, he added. He feels, however, that it may be impossible ever to deprive Chicago of all water which now is taken via the Chicago sanitary canal.

Fifth Annual Power Show To Stress Heating Exhibits

Much time and discussion on the relation of power to the industrial growth of nations and its importance as a factor in industrial relations has been devoted by the Institute of Politics at Williamstown, Mass. Statesmen and politicians are now giving the attention it deserves to a matter that has long been understood by engineers and manufacturing executives.

The tremendous influence of power on the industrial life of the United States is evident from the rapid growth in the national expositions of power equipment in this country, held at the Grand Central Palace, New York City. The coming National Exposition of Power and Mechanical Engineering, which will be held from Dec. 6-11, is the fifth in the annual series.

Four floors of the Grand Central Palace will be taken up with outstanding exhibitions of all types of mechanical equipment, including power generating, power using and mechanical power-transmission devices. Thus 450 manufacturing firms will be represented by interesting showings of important machines and apparatus in use throughout industry. In addition to the established sections of the exposition devoted to power and heat generating devices that have been so popular during the last four years, two special sections will receive attention during the coming year—that devoted to heating and ventilating equipment with 120 exhibits, and that devoted to mechanical power transmission equipment with about 60 displays.

During the week of the exposition two important technical meetings will be held, one by the American Society of Mechanical Engineers and one by the American Society of Refrigerating Engineers. The meeting of the mechanical engineers will last four days, Dec. 6-9, and will be made up of twenty-five sessions of technical papers held at the Engineering Societies' Bldg., 29 West 39th St., New York City The refrigerating engineers will meet at the Hotel Astor, Dec. 7-9. The sessions of both meetings are arranged to give those attending an opportunity to visit the power exposition.

The exposition is under the management of the International Exposition Co., Charles F. Roth and Fred W. Payne, managers, with offices in Grand Central Palace, New York City.

"U. S. Sale of Shoals Power Law Violation"—McKellar

In an issued statement opposing the lease of the Muscle Shoals plants to private interests, Senator K. D. McKellar of Tennessee further asserted that the temporary sale of electric power to the Alabama Power Co. is a specific violation of the law.

The government should carry out the terms of the act of 1916, under which the Muscle Shoals developments were made, and itself sell power to consumers within economical transmission distance of the plant, the Senator said.

Senator McKellar has repeatedly reiterated his stand in favor of public ownership and operation of the plants at Muscle Shoals, both as to hydroelectric development and the production of chemicals for fertilizers.

"No Political Delay" on St. Lawrence—Up Soon

With pointed denial that the action of the New York Water Power Board, relative to granting a license for development of the St. Lawrence River power, is being delayed for political reasons, John A. Knight, New York Senator and member of the State Water Power Commission, declared definitely in a statement issued Aug. 28 that the commission is functioning as rapidly as possible, and that a meeting will be called within the next ten days to pass upon the details of the proposed licenses.

"The state engineer and surveyor has made careful study of the whole matter," said Senator Knight, in part. "He submitted to the commission a comprehensive proposal of recommendations in the matter of leasing these rights on June 29. These were promptly approved in principle. The commission met on July 21, and it was then determined to have a draft made of a resolution covering the conditions on which any lease of water rights would be made. That has been prepared and is now being studied by the members. A meeting for action on this will soon be held.

"As is well known, there are two applicants for a lease. The next step will be the selection of the applicant to be given the lease and the submission of the terms following the resolution, now being considered. So it will be seen that the commission has not been dilatory. It has been moving along very expeditiously though carefully."

State Engineer and Surveyor Roy G. Finch stated last night that it is expected that a meeting of the Water Power Commission will be called within the next week or ten days

Niagara Report Submitted—Early Conference Likely

Maj.-Gen. Edgar Jadwin and Col. O. M. Biggar, technical representatives of the United States and Canadian governments, respectively, have submitted their report in connection with the proposed conference on the recession of Niagara Falls.

If the recommendations of the technical advisors are accepted the conference probably will be held in October or November. No information as to the contents of the report is being given out at the State Department.

As chief concern centers on the preservation of the scenic beauty of the Falls, the public conference that will be called is expected to deal largely with the means whereby the recession of the crest can be stopped and the scenic beauty of the Falls increased.

When the views of all those who are interested in the scenic beauty of the Falls have been recorded, the material will be turned over to the augmented Niagara control board, which will make the engineering studies. That board consists of Major Dewitt C. Jones, the district engineer at Buffalo; William H. Johnson, the permanent Canadian member of the Niagara control board; J. Horace McFarland, of Harrisburg, Pa., and another Canadian member. Mr. McFarland has been active since 1905 in matters pertaining to the scenic features of the cataract.

Water Power Commission Has Received 736 Applications

Five applications for licenses and one application for a preliminary permit under the Federal Water Power Act were filed with the Federal Power Commission in the five weeks' period ended August 21, according to a statement issued August 25. This brings the total of applications received since the commission was created, to 736.

Most important among these was that of the Tennessee Eastern Electric Company, of Johnson City, Tenn., has applied for preliminary permit for a power project on the Nolichucky River, in Greene, Unicoi, and Washington Counties, Tenn.

Three dams are proposed; one at Embreeville, one at Buckingham Ford, and one 12 miles downstream from the applicant's existing power plant on the Nolichucky River. The dams are to be from 70 to 90 feet high and the power plants proposed to be constructed in the project will have an installed capacity of 70,000 hp.

The primary capacity of the stream is 12,000 hp. The energy generated is to be used in the public utility system of the applicant.

Foshay Merger of Thirteen Companies Completed

The W. B. Forshay Co. has announced that the merger of 13 public-utility companies has now been completed. This consolidation has been under way for some time. The People's Light & Power Co. was organized as the holding and operating organization under which the 13 companies were merged. The properties consist of electric, gas, water and street railway units, and as has been previously stated when these were being acquired, the combined units represent a total value of more than $8,000,000.

The properties are located in Washington, Oregon, Arizona, Iowa, Minnesota, Wisconsin and Vermont, with the W. B. Forshay Co. the managing organization.

Fortieth Missouri Town Finds Purchase Cheaper

Finding it more economical to purchase electricity from the Union Electric Light & Power Co.'s great modern generating plant at Cahokia, than to generate it in its own excellent, oil engine municipally owned plant, the City of Farmington, Mo., will shut down its generating plant and will buy what current it needs for distribution from the St. Louis Company, according to the Missouri Committee on Public Utility Information.

Since December 31, 1922, Farmington is the 40th Missouri community to discontinue generation of electricity in its municipal plant.

West Kootenay Power Plans To Double Output

It is reported that West Kootenay Power Co. is planning to increase its power development at Bonnington Falls, on the Kootenay River, British Columbia, by 60,000 hp. Active construction work has started. The present installation at Bonnington Falls amounted to 40,000 hp., but a third unit of 19,000 hp. is being added to the plant, which will, it is expected, be in operation by the end of the present month. This will give the company a total capacity of 120,000 horsepower.

The East Kootenay Power Co. is also making extensions. In order to meet the increased demand for power, the company is installing an auxiliary steam plant, which will have a capacity of 5,000 kw.; it is understood that it will be in operation during the coming winter.

Broad River Power Company Now Working Parr Shoals

As part of an extensive program of power development undertaken by the General Gas & Electric system, the second unit at Parr Shoals steam station of the Broad River Power Co., a subsidiary, has started operation, supplying territory extending from Columbia, S. C., and adjacent points through to Spartanburg, and thence to Hendersonville in North Carolina. The new unit adds 30,000 kw. to the plant's original rated capacity of 12,500 kw., thus increasing the power capacity of this plant by over 200 per cent. In actual operation the original unit has attained a capacity of approximately 16,000 kw.

It is planned that ultimately the Parr Shoals steam station of the Broad River Power Co. shall have a capacity of 65,000 kw. and continue as the largest of six plants in the General Gas & Electric system in South Carolina.

Delivery by Plane Keeps Power Plant Running

Airplane delivery of machine parts was effected recently at a saving of $3,000 a day to the Hartford Steam Boiler Inspection & Insurance Co. A large sum also was saved by its policy holder, the Brooks-Scanlon Lumber Co. of Bend, Ore.

During a week-end shutdown of the Bend power plant, trouble was discovered with the electrical equipment by an inspector of the Hartford company, who wired to the office in Portland, Ore., for replacement parts. The distance by rail is about 600 miles over the Rocky Mountains, but the air route is only 270 miles. An airplane delivered the necessary equipment, weighing 125 lb., three hours after the order was received.

Additional Unit for Grand Falls Development

Four 20,000 hp.-units instead of three are to be installed at the Grand Falls development at New Brunswick, Canada. Changes also have been made in the intake plan. Work on the substructure of the power house is progressing rapidly and will be completed by the end of the working season.

M.I.T. Establishes Field Fuel Oil Station

A field station for the new School in Fuel and Gas Engineering and the School of Chemical Engineering Practice has been established at the Bayonne refinery of the Tide Water Oil Co. by the Massachusetts Institute of Technology.

For several years the Chemical Engineering department of Technology has been conducting, through the School of Chemical Engineering Practice, an important part of its graduate training in chemical engineering at field stations at Buffalo, N. Y., Bangor, Me., and Boston, Mass. There are six plants now co-operating with the institute in conducting field work in chemical engineering.

Quicksand Puts Michigan Plant Out of Action

Quicksand, underneath the power plant of the Michigan Northern Power Co., which supplies electricity for the local street car system and the furnace of the Union Carbide Co. plant, has so undermined the power house, that it has been forced to shut down.

Virtually all of the 500 Union Carbide company employees have been put to work on the repairs to the damages wrought by quicksand and rushing power canal water, to forestall any chance of the plant tumbling into the waters of St. Marys River.

Water Power Project Found Harmful to Navigation

Proposed hydro-electric development on the Holston River by the Tennessee Eastern Electric Co. will affect navigable waters, the Chief of Engineers reports. When the company first considered this development, it was thought no federal permit would be necessary. The company's declaration of intention, however, was referred to the Corps of Engineers, which held that a dam in the headwaters of the Holston should come under the purview of the water power act.

Italy Increases Her Hydro-Electric Production

Production of hydro-electric energy in Italy has increased rapidly, and it is estimated that the plants in operation in 1925 totaled 2,000,000 hp., according to advices to the Department of Commerce from the Assistant Commercial Attaché A. A. Osborne, at Rome.

The Associasione Nazionale Industire Electriche of Milan stated that the plants now under construction are of about 700,000 hp. It is believed in Italy that by the end of 1926 there will be about 2,341,000 kw. generated by hydro-electric plants, and there are a number of concession applications for another million kilowatts pending.

The production of electrical power increased from 1,961,000,000 kw.-hr. in 1913 to 5,500,000,000 kw.-hr. in 1925, and to about 6,000,000,000 kw.-hr. in 1926. The rapid growth of the production and utilization of electrical energy in Italy is believed to be indicative of the potential market for electrical apparatus and should command the attention of American manufacturers and exporters of such equipment, says the Department of Commerce.

Power Project Approved For Mississippi

Plans of a project for power development on the Mississippi River, at Morrison County, Minn., the application for which was made by the Minnesota Power & Light Co., have been approved by Major General Edgar Jadwin, chief of the Army engineers, and forwarded to the district engineer of that territory, it has been announced at the Department of War.

Pioneer Mine Power Company To Build New Plant

A new plant is to be erected by the Canada Electric Co., Ltd., near Maccan, Nova Scotia. This company is the pioneer producer of power from the pit mouth, the original plant at Chignecto, Nova Scotia, being the first in America to generate electricity from coal mined alongside the generating station.

Obituary

Professor Charles S. Brown, professor of mechanical engineering at Vanderbilt University, Nashville, Tenn., died Aug. 31 after a short illness. He was a graduate of Yale University of the class of 1883.

General George Uhler, formerly chief engineer on the Morgan Line Ships sailing out of New Orleans and president of the Marine Engineer's Benefit Association, died at his home in Washington, D. C., Monday, Aug. 23. After twenty-three years as supervising inspector-general for the United States steamship inspection service General Uhler resigned his office Dec. 31. 1925.

Personal Mention

Colonel William Kelly has resigned his work with the N.E.L.A. to become vice-president of the Buffalo Niagara & Eastern Power Corp., in charge of engineering and operation.

Major Howard Sharp Bennion, former assistant chief engineer of the Federal Power Commission, has been appointed director of engineering at the National Electric Light Association's headquarters to succeed Colonel William Kelly who leaves office the 15th of September.

Clayton H. Sharp, president of the United States National Committee of the International Electrotechnical Commission, and **Dr. C. O. Mailloux,** honor-

ary president and ex-officio member of the Committee of Action, plan to attend the meeting of the Committee of Action of that body to be held in London on Sept. 23.

Alexander Dow, president of the Detroit Edison Co., completed the thirtieth year of his service as head of the company on July 1. On July 1, 1896, he was appointed vice-president and general manager of the Edison Illuminating Co., and in December, 1912, he was elected president of the Detroit Edison Co. The title and duties of general manager he relinquished in February, 1923. As president and chief executive he continues to direct the larger affairs of the company.

Business Notes

The Morris Machine Works, of Baldwinsville, N. Y., removed its Cleveland office on Sept. 1 to 1367 East Sixth St., Cleveland, Ohio.

The Air Preheater Corp., 25 Broadway, New York City, announces that Howard Butt, formerly of the Riley Stoker Corp., has joined its sales staff. Mr. Butt is known throughout the power-plant field as well as in the steel industry.

The McClave-Brooks Co., manufacturers of McClave combustion systems, with headquarters at Scranton, Pa., removed on Sept. 1 the Atlanta branch office from 1212 Atlanta National Bank Bldg. to 1328 Candler Bldg., Atlanta, Ga.

The Austin Co., engineers and builders, of Cleveland, Ohio, announce with regret the sudden death of Claude F. Chard, who has been for several years Cleveland district sales manager. Mr. Chard was killed in an automobile accident on Friday, Aug. 13, while on route from Cincinnati to Cleveland.

The W. H. Taylor Co., of Allentown, Pa., has been appointed distributor for Quigley Furnace Specialties Co., Inc., of New York, covering the Allentown territory for all Quigley products, including Hytempite, acid-proof cement, Quigley refractory gun, triple-A protective solutions, etc., which will be carried in stock.

Yasudiro Sakai, consulting electrical engineer and registered patent attorney, assisted by Masaharu Hashimura, patent expert and attorney, has opened his office at 465 Marunouchi Bldg., Marunouchi, Tokyo, Japan. Mr. Sakai is specially equipped to handle the applications of foreigners for Japanese patent and trade mark registrations.

The W. A. Jones Foundry & Machine Co., of Chicago, announces the appointment of Ralph L. Shaw as Milwaukee district representative to fill the vacancy created by the resignation of Fred E. Holtz. Mr. Shaw will assume his new duties immediately, making headquarters at the present sales office of this company, 425 East Water St., Milwaukee, Wis.

The Carborundum Co., of Niagara Falls, N. Y., announces several changes among the personnel of its district sales managers. Farrand Hall, who has been sales manager of the Cleveland territory, has been transferred to the sales department at the main plant, Niagara Falls. The position of district sales manager in Cleveland will be filled by Harry Collinson who will be transferred from a like position at Milwaukee.

Coming Conventions

American Electric Railway Engineering Association. Annual Meeting at Cleveland, Ohio, Oct. 4-8. Papers in power field Oct. 7.

American Institute of Electrical Engineers. Pacific Coast Convention at Salt Lake City, Utah. F. Hutchinson, 33 West 39th St., New York City, Sept. 6-10.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Richmond, Va., Sept. 27-30.

American Welding Society. Annual Fall Meeting, at Buffalo, N. Y., Nov. 7-19. Gideon W. Swan, general chairman. First International Welding Exposition will be held in conjunction with meeting.

Association of Edison Illuminating Companies. Chateau Frontenac, Quebec, Sept. 27-Oct. 1. P. S. Millar, 80th St. and East End Ave., New York.

Empire State Gas and Electric Association. Lake Placid Club, N. Y., Sept. 30-Oct. 1. C. H. B. Chapin, Grand Central Terminal, New York.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14-17. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state associations are scheduled for the following dates: **New York State Association.** Wilmer T. Meinzer, 3626-215 Place, Bayside, Long Island, N. Y. Postponed from June 11 to 12, at Troy, N. Y., to Sept. 12-13 at Atlantic City, N. J. **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

New England Water Works Association, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

National Exposition of Power and Mechanical Engineering, Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

The Quigley Furnace Specialties Co., manufacturer of Hytempite, acid-proof cement, the Quigley refractory gun, Triple-A solutions, and other products, has acquired the services of S. F. Murphy, Jr., for the service department of the company. Making his headquarters at San Francisco, Mr. Murphy will cover the entire west coast, California, Colorado, Texas, Utah, Oregon, Washington, Wyoming, British Columbia and the Orient.

Trade Catalogs

Traveling Grate Stoker—The Combustion Engineering Corp., 43 Broad St., New York City, has issued Catalog C-4 on the Coxe traveling grate stoker. Installation pictures, performance charts, and a table of typical evaporative tests of Coxe stokers are outstanding features of this catalog.

Pipe Tools and Machines—The Oster Manufacturing Co., Cleveland, Ohio. American edition of List No. 35, covers the complete line of hand stocks and power driven pipe threading machines. Illustrations and tables present these products concisely. A thumb index adds to the catalog's handiness.

Ohio Brass Co. Catalog—This is Catalog No. 20 covering the products of the company for the year 1926-1927. High tension insulators, brass valves, trolley line materials, rail bonds and tools, third rail insulators and car equipment specialties constitute the main sections of this voluminous catalog of 945 pages. Thoroughly illustrated, tabulated and indexed, this issue is compactly arranged and strongly bound. A valuable and ready handbook of the Ohio Brass Co's. output.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Aug. 30 1926
Pool 1	New York	$2.40@$2.75
Smokeless	Boston	2.59
Clearfield	Boston	1.75@ 2.00
Somerset	Boston	1.85@ 2.10
Kanawha	Columbus	1.50@ 1.75
Hocking	Columbus	1.40@ 1.75
Pittsburgh	Pittsburgh	1.90@ 2.10
Pittsburgh gas slack	Pittsburgh	1.20@ 1.25
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.35
West Ky.	Louisville	1.10@ 1.35
S. E. Ky.	Louisville	1.50@ 1.85
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.75@ 3.50
Buckwheat No. 1.	Philadelphia	1.85@ 2.75
Birdseye	New York	1.25@ 2.00

FUEL OIL

New York—Sept. 2, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Aug. 25, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 6.37½c. per gal.; 38@40 deg., 7¼c. per gal.

Pittsburgh—Aug. 25, f.o.b. local refinery; 30@34 deg., fuel oil, 5.87½c. per gal.; 36@40 deg., fuel oil 6½c. per gal.

Dallas—Aug. 14, f.o.b. local refinery 26@30 deg., $1.75 per bbl.

Philadelphia—Aug. 26, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati—Aug. 31, tank-car lots f.o.b. local refinery, 24@26 deg., Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Aug. 23, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.40@$1.42½ per bbl.; 26@30 deg., $1.45@$1.50; 30@32 deg., $1.55.

Boston—Aug. 30, tank-car lots f.o.b. 12@14 deg. Baumé 4.48c. per gal.; 28@32 deg., 5.9c. per gal.

New Plant Construction

Ark., Osceola—Drainage District 17, of Mississippi County, will soon receive bids for the construction of a pump house, with screw pumps, either oil engine or motor driven. Estimated cost $75,000 to $100,000. O. M. Fairley, Osceola, is engineer.

Calif., Long Beach—P. J. Duncan, Pacific National Bank Bldg., Los Angeles, Archt., is receiving bids for the construction of 5 story cold storage warehouse, for Home Ice Co., Anaheim Rd., here.

Calif., Los Angeles—Lilly-Fletcher Corp., National City Bank Bldg., is having plans prepared for the construction of 12 story apartment at Rampart and Wilshire Blvd. Estimated cost $1,000,000. Walker & Eisen, Great Republic Bldg., are architects.

Calif., Los Angeles—Los Angeles Investment Co., c/o Walker & Eisen, Great Republic Bldg., will build 12 story office building on Broadway, near 10th St. Estimated cost $750,000. Work will be done by day labor.

Calif., San Francisco—Bakewell & Brown, Archts., 251 Kearny St., will soon receive bids for the construction of 6 story and basement hospital on Buena Vista Ave. for St. Josephs Hospital, Buena Vista Ave. Estimated cost $500,000. C. H. Snyder, 251 Kearny St., is engineer and Leland & Haley, 58 Sutter St., are mechanical engineers.

Calif., San Francisco—L. R. Lurie, 315 Montgomery Ave., is having plans prepared for the construction of 30 story Hotel Ritz Carlton, at Gough and Washington Sts. Estimated cost $5,000,000. Weeks & Day, 315 Montgomery St., are engineers and architects.

D. C., Wash.—District Commissioners, District Bldg., received no bids for the construction of power plant at Home for Aged and Infirm, here.

Ga., Homerville—City, A. H. Cupepper, Mayor, will receive bids until September 7 for 200 g.p.m. plunger type deep well pump and motor, etc. C. V. Dowling, Lake City, Fla., is municipal engineer.

Ill., Chicago—Hill State Bank, 3324 Lawrence Ave., is having plans prepared for the construction of 7 story, stores, office and bank building at Lawrence and Kimball Aves. Estimated cost $500,000. E. M. Vitzhum & Co., 307 North Michigan Ave., are engineers.

Ill., Chicago—Owner, c/o C. W. Christensen, Archt., 6582 Sheriden Rd., is having plans prepared for the construction of 12 story apartment, on Winthrop near Granville Ave. Estimated cost $500,000.

Ind., Vincennes—E. G. Spink, Indianapolis, is having plans prepared for the construction of 6 story hotel, at 4th and Main Sts. Estimated cost $500,000. W. K. Eldridge, 203 Medical Arts Bldg., Indianapolis, is architect.

Kan., Yates City—City is having plans prepared for the construction of low service pumping station, and water filtration plant and high service pumping station. Estimated cost $45,000. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., are engineers.

La., Baton Rouge—A. Glassell, Shreveport, awarded contract for the construction of 12 story hotel, here, to Glassell-Wilson Constr. Co., Inc., Sinclair Bldg., Shreveport, Estimated cost $1,000,000.

Mass., Arlington—Arlington Gas Light Co., 689 Massachusetts Ave., is receiving bids for the construction of 1 story, generator and boiler house, on Grove St. Estimated cost $75,000. W. M. Russell, 77 Franklin St., Boston, is engineer.

Mass., Cambridge (Boston P. O.)—Middlesex County Commissioners, A. Cutting, Chn., County Court House, is having plans prepared for the construction of a boiler plant at the county jail, East Cambridge. Estimated cost $175,000. E. C. Brown & Co., 220 Devonshire St., Boston, are engineers.

Mass., Newton—Newton Hospital, C. E. Kesley, Pres., is having sketches prepared for the construction of hospital building, nurses home and power plant on Beacon St. Estimated cost $1,500,000. Densmore, Le Clear & Robbins, Park Square Bldg., Boston, are architects.

Mich., Detroit — Electric Refrigeration Corp., awarded contract for the construction of 3 story factory on Pennsylvania Ave. and Pere Marquette R.R. tracks to H. W. Horst Co., Grand Rapids. Estimated cost. $2,000,000. Contractor will purchase steam heating equipment.

Mich., Detroit—L. Kamper, 204 Woodward Ave., Archt., will receive bids until September 10, for the construction of 34 story, office building, with electric elevators, steam heating equipment, etc., on Woodward Ave., for Eaton Estate, 204 Woodward Ave. Estimated cost. $1,000,000.

Minn., Austin—Board of Water, Electricity, Gas and Power Commissioners, will receive bids until September 7, for centrifugal steam turbine pump, 3,500 g.p.m., against 200 ft. head.

Miss., Biloxi—Dorries Hotel Co., c/o L. Braun, Howard Ave. and Lemeuse Ave. awarded contract for the construction of 6 story hotel, on East Beach St. to Kaucher-Hodges Constr. Co., Shrine Bldg., Memphis, Tenn. Estimated cost $500,000.

Miss., McComb—City, B. E. Butler, Clk., will receive bids until September 21, for complete sewage disposal plant, including pump pit, machinery, etc. H. A. Mentz, Citizens Bank Bldg., Hammond, La., is engineer.

N. H., Tilton—Tilton School awarded contract for the construction of a power house to C. S. Henry & Co., 82 Devonshire St., Boston. Estimated cost $40,000.

N. J., Atlantic City—W. M. Macy, Archt., Land Title Bldg., Philadelphia, will receive bids until September 15 for the construction of 15 story James Madison Hotel, at Virginia Ave. and Broadwalk for Virginia Hotel Corp.

N. Y., New York—A. N. Adelson, Inc., 65 West 39th St., awarded contract for the construction of 26 story, office, showroom and stores building at 2 Park Ave., to Shroder & Koppel, Inc., 347 Madison Ave. Estimated cost $9,000,000.

O., Avon Lake—Board Commissioners Lorain Co., will receive bids until September 15 for the construction of filter plant, low service pump house, pumping equipment, etc. Estimated cost $150,000. G. B. Gascoigne, Leader Bldg., Cleveland, is engineer.

O., Cleveland—City is having preliminary plans prepared for the construction of pumping station and filtration plant at Chardon Rd. and St. Clair Ave. Estimated cost $1,500,000. L. A. Quayle, City Hall, is engineer.

O., Cleveland—Cleveland Aerie of Eagles, J. E. Sperry, 302 Pittsburgh Bldg., St. Paul, Chn. Building Com., will receive bids until September 14, for the construction of 10 story lodge building, with steam heating equipment and elevators, etc. Estimated cost $1,250,000. G. F. Stewart, 302 Pittsburgh Bldg., St. Paul, is architect.

Okla., Cyril—City, J. C. Wolfe, Mayor, is in the market for 70 g.p.m. deep well pump and 15 hp. motor.

Okla., Ponca City—City plans an election to vote $160,000 bonds for installing 1500 hp. Diesel engine and generator, in light plant. J. W. Crow is superintendent.

Pa., Ardmore—Health and Drainage Committee, G. C. Anderson, Secy., Lower Merion Twp. Office, 75 East Lancester Ave., will receive bids until September 8, for 1 or 2 motor driven centrifugal sewage pumps and removing existing pumps from Ardmore Pumping Station.

Pa., Pittsburgh—Beverly Building Co., c/o F. H. Smith Co., Philadelphia, awarded contract for the construction of 21 story, office building at 4th Ave. and Cherry Way, here, to Boyle-Robertson Constr. Co., Evans Bldg., Washington, D. C. Estimated cost $2,500,000.

Pa., Pittsburgh—Stanly Corporation of America, 1916 Race St., Philadelphia, is having plans prepared for the construction of 20 story theatre and office building at 7th and Liberty Sts., here. Hoffman-Menen Co., Franklin Bldg., Philadelphia, is architect.

Pa., Pittsburgh—Webster Hall Corporation, Majestic Bldg., Detroit, Mich., awarded contract for the construction of 9 story apartment at Bayard and Melwood Aves. to Everett Winters Co., 1651 Grand Blvd., Detroit, Mich. Estimated cost $500,000.

Pa., Pottsville — Pottsville Community Hotel, Inc., awarded contract for the construction of hotel, here, to Day & Zimmermann, 1600 Walnut St., Philadelphia. Archts. est. $600,000.

Tex., Amarillo—W. S. Rule is having contract awarded for the construction of 8 story office and garage building with steam heating system, etc., at 3rd and Polk Sts., to Manhattan Construction Co., Muskogee, Okla. Estimated cost $750,000.

Tex., Brownsville—City plans an election to vote $100,000 bonds for extending electric light lines, purchasing turbine, etc.

Tex., Canton—City voted $25,000 bonds for constructing waterworks system, including pumping equipment, etc.

Tex., Corpus Christi—Central Power & Light Co., c/o E. B. Neiswanger, Mgr., Frost Bldg., San Antonio, plans increasing plant here from 23,000 to 36,000 volts. Owners will purchase equipment, including 4,600 hp. turbine, two 600 hp. Edgemoore boilers, steel substation, etc. Estimated cost $500,000.

Tex., Corpus Christi—Nueces Hotel, c/o W. W. Jones, is having plans prepared for the construction of power house including machinery, etc. Estimated cost $50,000. Private plans.

Tex., Fort Worth—R. O. Dulaney, F. & M. Bank Bldg., awarded contract for the construction of 12 story office building at 6th and Throckmorton Sts. to H. B. Friedman, 402 1st National Bank Bldg. Estimated cost $700,000.

Tex., McAllen—City is having plans prepared for the construction of sewage disposal plant, including pumps, etc. Estimated cost $35,000. Card & Parks, are resident engineers.

Tex., Mirando City—Texas Central Power Co., Frost Bldg., San Antonio, has purchased power plant, here, and plans doubling present capacity and installing new machinery, including engine, turbine, etc. Estimated cost $35,000. Private plans.

Tex., San Antonio—City is having preliminary plans prepared for installing a refrigerating machine in new municipal auditorium. I. Ewig is city engineer.

Tex., San Antonio—J. B. Herff and C. H. Timmins, Medical Arts Bldg., are having plans prepared for the construction of 15 story office building at Avenue E and 4th Sts. Estimated cost $1,000,000. Private plans.

Tex., Stephenville—City is receiving bids for the construction of waterworks improvements, including pumping machinery, etc. Estimated cost $40,000.

Tex., Wichita Falls—City plans waterworks improvements, including new or enlarged pumping plant, and new power plant, etc. Estimated cost $1,000,000. Black & Veatch, Mutual Bldg., Kansas City, Mo., are engineers.

Tex., Wichita Falls—New Ice Co., c/o J. McKemie, Jr., 1008 Indiana St., will soon receive bids for construction of 60 ton capacity ice plant. Estimated cost $100,000. Owners will purchase equipment.

Wash., Olympia—City plans an election November 2, to vote $250,000 bonds for port improvements, including a cold storage building, etc. E. L. Van Epps is engineer.

Wis., Milwaukee—Central Board of Purchase, City Hall, J. W. Nicholson, chief buyer, will receive bids until September 9, for 600 transformer coils for street lighting system.

Wis., Milwaukee—M. Tullgren & Sons Co., 9 Waverly Pl., are preparing plans for the construction of hotel at north end Juneau Park. Estimated cost $1,000,000. Owners are architects.

B. C., Vancouver — Canadian National Railways, Ottawa, Ont., awarded general contract 12 story hotel on George St. to E. J. Ryan Contg. Co., Ltd., 445 Granville St. Estimated cost $3,500,000.